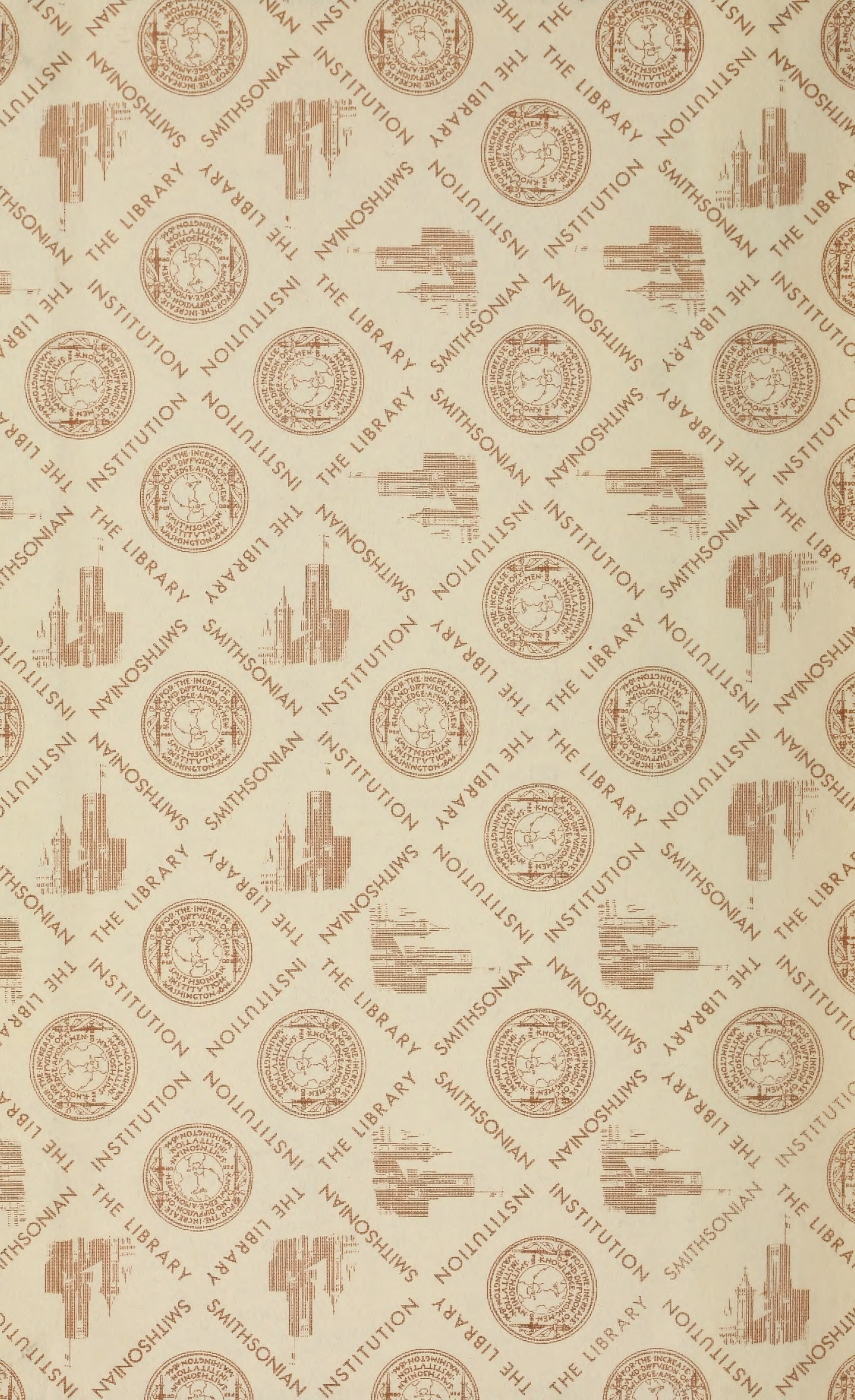
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J. C. Dickinson, Jr., *Editor*

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CONTENTS OF VOLUME 21

Number 1

Comments on Teaching. *By J. Speed Rogers* 3

A Study of the Interrelations of Selected Chemical and Physical Factors in the Suwannee River. *By William M. Beck, Jr.* 12

A List of Mayflies from the Lower Apalachicola River Drainage. *By Lewis Berner* 25

Call Difference as an Isolation Mechanism in Florida Species of Hylid Frogs. *By W. Frank Blair* 32

A Comparison of the Nonbreeding Habits of Two Treefrogs, *Hyla squirella* and *Hyla cinerea*. *By Olive B. Goin* 49

Comments Upon the Origin of the Herpetofauna of Florida. *By Coleman J. Goin* 61

The Evolutionary History of the Pictus Group of the Crayfish Genus Procambarus (Decapoda, Astacidae). *By Horton H. Hobbs, Jr.* 71

In Defense of the Concepts of Major and Minor Habitats in Approaching Biological Problems. *By Frank N. Young* 92

A Report on Succession Studies of Selected Plant Communities on the University of Florida Conservation Reserve, Welaka, Florida. *By Albert M. Laessle* 101

Number 2

Fossil Fish Teeth of the Family Sparidae from Florida. *By David K. Caldwell* 113

A New Fish of the Genus *Ophioscion*, Family Sciaenidae, from Caribbean Costa Rica. *By David K. Caldwell* 117

Notes on the Eggs and Larvae of *Eurycea lucifuga* Rafinesque. *By Charles W. Myers* 125

Dosimetry Determinations of Gamma Rays in an Underground Co^{60} Source. *By M. Sakuntala, M. F. Argus, and F. E. Ray* 131

Notes on the Barred Pattern in the Sheepsheads, *Archosargus probatocephalus* and *A. oviceps*. *By David K. Caldwell* 138

Notes on the Development of *Anadyomene stellata* (Wulf.) C.A.G. *By Ronald C. Phillips* 145

Lithologic Features of Miocene Sediments Exposed in the Devil's Mill Hopper, Florida. *By E. C. Pirkle* 149

The Problem of Bias on the Part of the Researcher in the Social Sciences. *By Peter Lars Sandberg* 162

A New Family of Miocene Salamanders from the Texas Coastal Plain. *By Walter Auffenberg* 169

A Synopsis of *Gnaphalium* (Compositae) in the Southeastern United States. *By R. K. Godfrey* 177

Extension of Distribution of *Ruppia maritima* var. *obliqua* (Schur.) Aschers. and Graebn. *By Ronald C. Phillips* 185

Jellied Condition in *Paralichthys squamilentus* from the Gulf of Mexico. *By Eugenie Clark* 187

Research Note—Additions to the Fishes of Cedar Key, Florida, and a List of Gulf of Mexico Carangidae 190

NUMBER 3

Synopsis of the Florida Species of *Cacalia*. *By R. Kral and R. K. Godfrey* 193

Giant Toads of Florida. *By William J. Riemer* 207

Antibody Response to Rat Gastric Mucosa. *By Angeline Elder, Mary F. Argus and Francis E. Ray* 212

Luigi Ferdinando Marsigli, the Lost Father of Oceanography. *By F. C. W. Olson and Mary Ann Olson* 227

Leptocephalus of the Atlantic Tarpon, *Megalops atlanticus* Valenciennes, from Offshore Waters. *By Jack W. Gehringer* 235

Amebas of Warm Mineral Springs, Florida, Including *Cochliopodium papyrum* n. sp. *By Eugene C. Bovee* 241

A Small Fossil Herpetofauna from Barbuda, Leeward Islands, with the Description of a New Species of *Hyla*. *By Walter Auffenberg* 248

A New Species of the Boarfish Genus *Antigonia* from the Western Atlantic. *By Frederick H. Berry and Warren F. Rathjen* 255

Studies on Helminth Parasites from the Coast of Florida. IV. Digentic Trematodes of Marine Fishes of Tampa, Boca Ciega Bays, and the Gulf of Mexico. *By Franklin Sogandares-Bernal and Robert F. Hutton* 259

Notes on the Eggs and Young of *Gopherus polyphemus* (Daudin). *By Andrew A. Arata* 274

Effect of Stage of Gestation, Dietary Energy and Progesterone on the Succinoxidase of Swine Uteri. *By R. L. Shirley, C. E. Haines, A. C. Warnick, H. D. Wallace, and G. K. Davis* 281

On the Status of the Atlantic Leatherback Turtle, *Dermochelys coriacea coriacea,* as a Visitant to Florida Nesting Beaches, with Natural History Notes. *By David K. Caldwell* 285

NUMBER 4

High Hammock Vegetation of the Southern Florida Mainland. *By Taylor R. Alexander* 293

Ecology of the Pompano Beach Hammock. *By Taylor R. Alexander* 299

Marriage Patterns Among Evening College Students. *By Richard K. Morton* 305

Effect of Chlortetracycline on the Succinoxidase and Lactic Dehydrogenase of the Heart of Swine and Cattle. *By R. L. Shirley, J. I. McKigney, H. D. Wallace, J. F. Hentges, Jr., and G. K. Davis* 312

Observations on the Ecology of a New Population of the Mediterranean Gecko, Hemidactylus Turcicus, in Florida. *By Wayne King* 317

Awareness of Florida College Students of the State Nuclear Program. *By Charles M. Grigg and Francis R. Allen* 319

Further Notes on Trematoda Encysted in Florida Mullets. *By Robert F. Hutton and Franklin Sogandares-Bernal* 329

Morphological and Biochemical Studies on the Organism *Sphaerotilus natans.* *By Sumner Waitz and James B. Lackey* 335

Studies on Water Relations in Florida Termites. I. Survival Time and Rate of Water Loss During Drying. *By Margaret S. Collins* 341

Two New Species of *Lyngbya* C.Ag. *By Ronald C. Phillips* 353

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# of the
Florida Academy
# of Sciences

Vol. 21 March, 1958 No. 1

Contents

Rogers—Comments on Teaching 3
Beck—A Study of the Interrelations of Selected Chemical and Physical Factors in the Suwannee River 12
Berner—A List of Mayflies from the Lower Apalachicola River Drainage 25
Blair—Call Difference as an Isolation Mechanism in Florida Species of Hylid Frogs 32
Goin—A Comparison of the Nonbreeding Habits of Two Treefrogs, *Hyla squirella* and *Hyla cinerea* 49
Goin—Comments Upon the Origin of the Herpetofauna of Florida 61
Hobbs—The Evolutionary History of the Pictus Group of the Crayfish Genus *Procambarus* (Decapoda, Astacidae) 71
Young—In Defense of the Concepts of Major and Minor Habitats in Approaching Biological Problems 92
Laessle—A Report on Succession Studies of Selected Plant Communities on the University of Florida Conservation Reserve, Welaka, Florida 101

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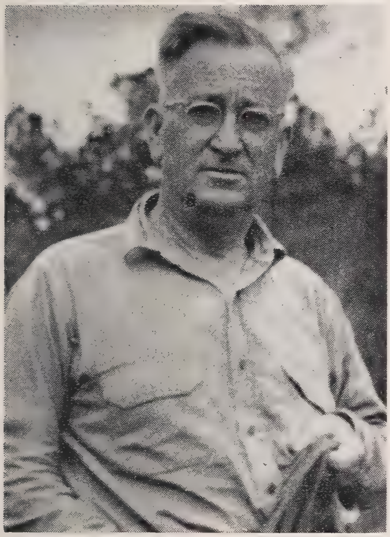
J. SPEED ROGERS

1892-1955



J. Speed Rogers.

J. Speed Rogers a charter member of the Florida Academy of Sciences left an indelible mark on teaching and research in biology in Florida. As a charter member Dr. Rogers was instrumental in the formation of our organization. Indicative of his influence and belief in the Florida Academy is the fact that even those contributors to this number who have been long gone from the state still maintain their active membership. Students, both undergraduate and graduate, were urged to join the Academy and to participate in its activities. As one of the early Head Professors of Biology at the University of Florida, Speed watched and abetted the growth of his department from a one man staff in 1922 to a congenial and productive group of fourteen in 1946, when he left to assume the directorship of the Museum of Zoology at the University of Michigan. As a systematist and natural historian, he emphasized his own interests in developing his staff and the graduate teaching program in his time was a reflection of this pattern. The articles in this special number of the Quarterly Journal authored by some of his former students and especially gathered here in his memory, deal with prob-

SMITHSONIAN INSTITUTION AUG 28 1958

lems in biology dear to Speed's heart. As an introduction to this collection, we have included an unpublished (and unpolished) manuscript which came to our hands a few years ago. This is the basis of a talk which Dr. Rogers delivered to the Atheneum Club at the University of Florida. The sentiments expressed are so truly Rogersian and timeless that they remain appropriate today. As a former student, we are pleased and proud to have had a small hand in bringing this memorial to him to his many friends in the Academy.

THE EDITOR

COMMENTS ON TEACHING

J. Speed Rogers

To the
Teachers of Zoology
who have beheld their subject outgrow a pedagogical method.

I have chosen for my subject, this evening, an account of a teaching tradition that has been exceedingly fruitful in biology. I am not sure that I should use the perfect tense; isolated examples of the tradition linger on in some of our graduate schools, museums and laboratories and something of its influence is still discernable in some of the present attempts to fit biological teaching to mass methods.

In the history of biology there have been some notable teachers, men who attracted to their laboratories a surprising number of capable and original students and sent them out to become productive and often brilliant leaders of the next generation. I need only mention Johannes Müller whose students largely created modern physiology and revolutionized comparative morphology and of course Thomas Huxley and Louis Agassiz. Here are three men—others could doubtless be cited—who, although first rank researchers and authorities in their own right, are probably best remembered for the remarkable productiveness of the students they trained and inspired; students who in a large part handed on to a still larger third generation the methods and enthusiasm of their master.

Of these three men it is Louis Agassiz who is of special interest to us, for his teaching was done in America during one of the most critical and formative periods of American biology. It is his influence and the tradition that he left that I wish particularly to discuss.

Although much of Agassiz's success and most of the reverence in which he was held were due to a remarkable and lovable personality and to his enthusiasm and mental honesty, the "Agassiz Method" of teaching made a tremendous impression on all his students and became the part of their heritage from him they could most concretely hand on in turn to their own students. It was of much interest to me to discover that this "Agassiz Method" was not original with Agassiz but was acquired in large part from one of his own teachers, Ignatz Döllinger, who taught first at Wurtzberg and then at Munich during the first quarter of the 18th century. Aside from a brief but very grateful and affectionate tribute, quoted by one of Agassiz's students, I cannot find any reference that Agassiz has given to his work under Döllinger, but a very vivid account of Döllinger and his methods is given in the autobiography of Karl von Baer, the founder of modern embryology and one of the great names in the history of biology.

Much of von Baer's autobiography is taken up by an account of his education. After two capable tutors had trained him in languages and mathematics and three years in a public school, which von Baer regarded as for the most part efficient and valuable, he entered the University of Dorpat as a student of medicine. Here after four years he graduated as a M.D. but extremely conscious that he had neither received the requisite information nor any training in methods that would enable him to help himself. People told him that in Vienna there were great hospitals and that much was to be learned from Hildenbrand who had just published a work on Typhus. At Vienna he gave himself seriously to hospital work in medicine and surgery and found more competent instruction. Still dissatisfied, he began to question whether he should continue in medicine. He thought of teaching botany for a living; but in the Baltic provinces where his hopes of promotion lay, there was one chair of botany and that was then occupied. Moreover good instruction in natural history was not to be had, even if there had been the prospect of ultimate preferment. The new studies of geology and comparative anatomy rose before him like ranges of distant mountains, unknown but fascinating. All of these dreams, these longings for congenial work had as yet no practical possibility for the young doctor of medicine. Time after time, he broke away from hospital practice to delight himself in natural history, but always in the end repressed the rash impulse and forced his mind to run in the groove of practical medicine.

A little incident which at the time seemed absolutely trivial, proved to be the turning point in von Baer's career. While making a botanical excursion in the mountains near Vienna he fell in with two strangers, one the well known botanist, Hoppe, the other a young man, afterwards to be widely celebrated as Martius, the traveller and monographer of palms. Talking together Baer happened to mention that he was about to visit Wurtzberg for the sake of hospital practice. Martius, who had just finished his studies at Wurtzberg, begged von Baer to take charge of a packet of mosses which he wished to send to Döllinger. "Certainly," said von Baer, "but who is Döllinger?" "An anatomist who can give you instruction in comparative anatomy if you want it." This chance remark excited von Baer's hopes. Instruction in comparative anatomy was precisely what he did want and not many days later, he introduced himself to Döllinger, handed him Martius' packet of mosses, and explained that he himself had come to Wurtzberg to attend the course of lectures in comparative anatomy. "But, I don't lecture in comparative anatomy this term" was the answer. von Baer stood perplexed, the bottom knocked out of his plans. Then Döllinger, at length, went on: "What do you want with lectures? Bring me any animal you please, first one and then another, and dissect them here." The next morning von Baer brought a leech to Döllinger, who showed him what instruments to buy, how to kill the leech and how to prepare it for dissection under water. Slowly and clumsily the work went on. When it was finished Döllinger brought out Spix's beautiful memoir on the leech and gave it to Von Baer to study at home. Now von Baer saw what was to be done and returned to his leech with fresh interest. Other types were taken up one after another in the same way. Döllinger was at hand to explain points of unusual difficulty, but in general he went on with his own work, mounting his mosses, or examining them under the microscope. Von Baer tells us that before he had worked under Döllinger for a fortnight he was sure that he was on the right track, and day by day could see distinct progress, some new fact gained, some new method practiced. All the doubts as to what and where he should study were dispelled. Now he knew what he was fit for and was content to let the future shape itself.

Döllinger's methods were then new in the world. They originated in his own simple and practical character. It was usual during von Baer's student time to lecture profusely. The Professor of Zoology lectured upon the classes and orders of the animal kingdom. If more detail were wanted he lectured upon the genera and species. Döllinger swept all this aside and went straight to the real point. The student was to work for himself, to work under direction but actively and responsibly. A fresh set of difficulties now come in but they are difficulties well worth facing. Young men gradually learn to be careful and systematic, to trust their own eyes, to walk without leading strings.

One thing which is related concerning Döllinger's lectures is thoroughly characteristic. He hated all preludes, introductions, trivial facts, quotations and what von Baer called "learned nimbus". Pertinent data was reviewed, the essential points were explained until they were clear, and all the rest was passed by.

Döllinger, says von Baer, was first and last a teacher. Although always busy with research problems he had little care to win fame for himself. He would hand over to a good student one of the most promising leads that opened up in his own investigations. It was his delight to have students about him in his home; some of them lived with him and worked in his own study. If a student was very poor, Döllinger contrived to find him food and lodging; if he were rich Döllinger interested him in setting about some piece of work which required an outlay of money. To those who know something about the history of biology it is enough to say that Döllinger trained Purkinje, Martius, von Baer and Agassiz.

But, to return to Agassiz.

Louis Agassiz was born at Mofier in Switzerland in 1807. At the age of ten he was sent away to a school at Bienne where he stayed four years. His parents had intended Louis for a commercial life but his own hopes and ambitions lead in other directions and the profession of medicine was decided upon. After two years at the college of Lausanne he went to the medical school at Zurich and in 1826, at the age of 19 to the Univ. of Heidelberg in Germany. The four years of university life in Germany were divided between Heidelberg and Munich. The new University at Munich had opened under brilliant auspices with a remarkable faculty (including Döllinger) and was attracting many students and so after one year at Heidelberg, Agassiz migrated to Munich with his closest friend Alexander Braun. At Munich these two, together with Karl Schimper formed a close association, partly for the sake of economy in light, heat and food and partly from kindred interests in natural history. Braun in one of his letters home gave this description "A live gudgeon with beautiful stripes is wriggling in Agassiz's wash bowl and he has adorned his table with monkeys. We stay together in his room or mine by turns so as not to need heat in two rooms and not to burn twice as much for light . . . Under Agassiz's new style of house keeping the coffee is made in a machine which is devoted during the day to the soaking of all sorts of creatures for skeletons and in the evening again, to the brewing of tea."

Several years earlier the King of Bavaria had sent an expedition to Brazil to collect specimens of plants and animals. The results of the expedition were in course of publication in a number of sumptous volumes, but in 1826 the author of the zoological series died. This left the fishes undescribed and when the editor looked around for a suitable man to deal with this subject, he decided upon the young student Agassiz. This was an extraordinary compliment and although it meant a further encroachment upon the time devoted to medical studies the task was duly accepted.

Having duly graduated at Munich, Agassiz returned to Switzerland where he made at least a pretense of setting up a medical practice. He was however filled with the idea of writing a great work on fishes, particularly fossil fishes, a subject then greatly neglected. So we find him going to Paris where he sought the acquaintence of Cuvier, an aristocratic genius, the first zoologist of his times and one of the great leaders of French science. Cuvier received him politely and soon took a strong personal interest in his work. After a time, when thoroughly satisfied with the young man's ability, Cuvier produced a portfolio of his own notes and drawings on fossil fishes. This he placed in Agassiz's hands saying that he had himself intended to prepare just such a work as Agassiz had in mind but that he now felt that Agassiz was the one to do it. Agassiz, communicating this news to his grandfather, wrote, "You can imagine what new ardor this has given me for my work—I work regularly at least fifteen hours a day, sometimes even an hour or two more; but I hope to reach my goal in good time." Later he was almost compelled to abandon his labors and return prematurely to Switzerland because of lack of funds. Fortunately another great scientist, Alexander von Humboldt learned of his distress and supplied him with a considerable sum of money.

Agassiz went to Neuchâtel Switzerland in 1832 and there taught and wrote until 1845. Although this was a time of increasing financial difficulty it was the time of his most brilliant and important scientific work. Aside from the great work on fossil fishes which appeared in parts between 1833 and 1844 and numerous lesser but important works on other groups of animals both living and fossil, he developed and presented his great theory of glaciation; then astounding and only to be accepted after it had met tremendous objection and ridicule—now a commonplace in geological science.

As time passed, Agassiz's financial condition became worse and worse until it was really desperate. Something had to be done. At this juncture the Lowell Institute of Boston asked him to deliver a course of lectures at Boston and at about the same time the King of Prussia, through von Humboldt's instigation, offered him three thousand dollars to be used for scientific travel. Consequently in October 1846, Agassiz arrived in Boston, and gave a series of lectures, on the "Plan of Creation". He had little experience in speaking English but he could illustrate his meanings by drawings in chalk and his audiences were from the first not merely sympathetic but charmed. No one in this country had ever been able to make natural history so interesting. Agassiz on his part was amazed and delighted at the warmth of his welcome and the amount of money he was able to earn. At last the burden of debt was lifted and he was square with the world. He had meant to return to Switzerland but he had not been long in America when news came of his wife's death and gradually his home ties seemed to weaken as those with the new world increased. In 1848 he was offered a professorship at Harvard and, in view of the then unsettled state of Europe he was glad to accept.

From 1848 to the time of his death in December, 1873, Agassiz devoted himself to the development of American zoology. In this quarter of a century he did much work of his own and planned much more, and though his researches were not equal to those done during the brilliant 13 years in Switzerland they were of immense value in that they delt with peculiar American problems. In America, however, he is rememberd chiefly as the great teacher, the one who, whatever he did himself, stimulated others as no one else could do. No doubt all of the ablest men in the country with zoological leanings flocked to him; he had before him the best material America could furnish; but all of those who labored successfully under his guidance united in their tribute to his power as a teacher. Others there were with whom he could do nothing; he made no concessions to laziness or want of zeal, but expected to find industry and enthusiasm resembling his own.

The ever-increasing number of students—although his largest classes would seem quite small today—made the lack of teaching facilities a growing embarassment. Lecture rooms were plentiful, the library was rapidly becoming satisfactory but these were definitely only accessories to what he regarded as the real needs.

From his efforts to supply these needs grew the Museum of Comparative Zoology at Harvard, a research and teaching museum combining something of the functions of a museum and a laboratory, and the biological station on the Island of Penikese—off the heel of Cape Cod—where a rich marine biota, in a wholly natural environment, was available for unlimited study. It is worth noting in passing that the Museum of Comparative Zoology became the model and one of the best examples of a special type of University Museum, staffed by research workers rather than by curators in the narrow sense, and devoted to research rather than exhibits; while the Biological Station on Penikese was the prototype first for Woods Holl, then Cold Spring Harbor and finally the several score of marine and inland biological stations where much of the best teaching and research in biology is today carried on.

In the twenty-five years of his teaching in America the list of students who worked under him includes probably a majority of the most eminent naturalists who worked in America in the last quarter of the nineteenth century: David Starr Jordan, the great authority on fish and geographic distribution of animals, and who was to become Professor of Zoology and President of first Indiana and then Leland Stanford Universities; Brooks who was to found the Zoological Department at Johns Hopkins; Whitman who was to found a similar department at Chicago; Wilder at Cornell; Mark, Agassiz's successor at the MCZ; Snow at Kansas; Minot, the great American embryologist; Shaler at Harvard; and Scudder, Dall, Packard, Hyatt, Verrill, Morse, Garman, Faxon, each to become an authority and an outstanding research worker in some branch of biology. Of these Jordan and Wilder have left published accounts of their work and relationships with Agassiz but the most vivid account that I have met was related to me at various times by one of Brook's students.

Agassiz was usually on most intimate and friendly terms with his students but he demanded serious purpose and ability. At the first great summer at Penikese he had selected 35 men and 15 women from the more than 150 candidates who applied to come. On the second or third night of the stay on the island some six Harvard and Amherst men who objected to co-education made a huge doll of pillows and blankets and tossed it into the women's dormitory where it caused a certain amount of commotion. At breakfast the next morning Agassiz read the names of the six men and told them they would take the ten o'clock boat back to the mainland. No pleading or excuses were accepted. He admitted that it was a harmless student prank but they were at Penikese for work.

Brooks used to relate that when a student with little or no previous experience in biology came to Agassiz and asked to work under him his reply was usually to this effect "Here is a frog, or a sea-urchin, or a starfish", as the case might be, "when you have learned all you can about it bring it back and tell me what you know". If the work was well and intelligently done other animals would be handed out and if the student showed good progress he would be accepted; otherwise he was kindly but firmly told to try some other field of work. But to the students whom he accepted, Agassiz was an inspiration and a friend indeed. He assumed that they had equal enthusiasm and singleness of purpose and treated them as intellectual equals. His idea of teaching was to present a worthwhile problem, one that needed doing to advance the science of biology, to make suggestions as to methods of attack and then allow the student to learn. He gave problems, methods, and enthusiasm but rarely conclusions and never dogmas. It is noteworthy, I think that although Agassiz was to the last in his philosophy of biology, an old-school natural philosopher, and an uncompromising opponent of evolution, his students without exception became evolutionists and not a few of them made notable contributions to research in this field.

By no means all of Agassiz's students became professional biologists. You may recall in the Centennial number of the Atlantic monthly, which reprinted some of the noteworthy contributions to that magazine for the past hundred years, the story by Dallas Lore Sharp, entitled "Turtle Eggs for Agassiz". Certainly Sharp and other non-biologists who had the good fortune to come in contact with Agassiz not only felt the life-long influence of his personality and enthusiasm but gained a true amateur's love of nature and natural history.

A considerable part of the Agassiz tradition was the absolutely taken-for-granted assumption of Agassiz and all his students that the teacher of biology must be first of all a student and a worker in the field himself. Certainly Agassiz and Jordan, Brooks, Whitman and Wilder all great teachers, looked upon teaching as an extremely important contribution to biology but as necessarily a by-product to being biologists. It was not as a matter of relative worthwhileness but of necessity that they regarded themselves as biologists first and then teachers. Agassiz, Jordan and Brooks, and I have no doubt the others as well, were extremely kindly men who found great pleasure in their personal contacts and life-long friendships with their good students but this relationship had to be won by the capacity and worth of the student. Once won the relationship was that of friendly colleagues engaged on a common task; and no work on the behalf of the student was regarded as too much of a task; but this left no great surplus of personal interest for the student who had not qualified.

But the whole Agassiz tradition was built upon two conditions that did not fit well into the changing conditions brought about by huge university enrollments. It presupposed a relatively few highly selected students who were intensely interested in zoology. Requirred courses and mass education gradually made the method inefficient. In the average undergraduate course the emphasis that automatically came to be placed on information rather than understanding, evaluating was all in terms of grades and credits, and dependence was placed upon teaching rather than learning. The reaction of the last survivors of Agassiz's students to this tendency was rather amusing. In the period of about 1910-1915, Science and some other journals very frequently printed selected lists of prize boners conned from examinations. More than once such a list resulted in a reply from one of the old Agassiz group and such replies usually had the character of a distinct snort of disgust. Was it the fault of the teaching that such muddled misconceptions could exist—if the teaching was good then here was a most inefficient waste—that class room and laboratory should be cluttered up and that a teachers time needed for good students should fall on such barren soil!

Without doubt the Agassiz method is too expensive for the large number of present day undergraduates with anything remotely approaching present day budgets. Even in many graduate schools mass production methods have made such a method exceedingly dilute if not altogether inoperative. And yet I believe that nearly all working biologists will agree it was the most fruitful method ever used.

Quart. Journ. Fla. Acad. Sci., 21(1), 1958.

A STUDY OF THE INTERRELATIONS OF SELECTED CHEMICAL AND PHYSICAL FACTORS IN THE SUWANNEE RIVER

William M. Beck, Jr.
Florida State Board of Health

Introduction

The Suwannee River occupies a unique spot in the hearts of Floridians. Visitors to the State frequently find the great sentimental attachment to this stream difficult to comprehend. Certainly there are many other rivers with various unusual features of interest to scientist and casual observer alike. Yet when we examine the Suwannee River we are forced to wonder if this stream is not indeed unique. Consider a river which became world-famous because of a song written by a man who never saw the stream; a river having two major tributaries which suddenly disappear; a river having a waterfall in its basin, a rare sight indeed in Florida; a river with a smooth, placid surface and dark, cool waters suggesting peace and restfulness and yet having currents which can be extremely dangerous. In addition, any student of geography can readily appreciate the fact that the economy of the basin is virtually independent of the Suwannee River, a most unusual feature in a large stream.

In 1952 a study was begun of the chemistry, physics and biology of the Suwannee and its major northern tributary, the Withlacoochee River, in order to determine water quality prior to the operation of a paper mill then under construction in the basin. This study continued through 1953, with a complete run of all stations made each month.

After a few months it was apparent that some rather striking relationships between chemical and physical factors existed in these streams. We found that it was possible to predict the variations in several factors from month to month by merely noting the level of the water. It is with these interrelations that the present paper is concerned.

The material here presented is but part of a much lengthier study of the limnology of the Suwannee and Withlacoochee Rivers. Since this longer report promises to be delayed, the present material is presented because of its interesting and, apparently, unique nature.

The survey of these streams was undertaken jointly by the Florida State Board of Health and National Container Corporation, the latter the owners of the new mill mentioned above. Personnel representing both organizations made a sampling trip each month, beginning on the Withlacoochee River in Georgia well above the location of the mill and continuing to Branford in Suwannee County, Florida.

This report will be concerned with only three of the stations of the survey, all in the Suwannee River below its confluence with the Withlacoochee River.

The Suwannee River rises in the great Okefenokee Swamp in southeastern Georgia and flows in a general southwesterly direction to join the Withlacoochee at Ellaville, Madison County, Florida. Station 12, located just below the confluence of the two streams, was abandoned early in the survey because of insufficient mixing of the two stream contributions and our inability, therefore, to obtain representative samples. Station 12 is of importance because it is the location of a U. S. Geological Survey gauging station from which we obtained records of discharge for stations 13 (16 miles downstream), and 14 (31.5 miles below Ellaville), both downstream. Station 15 (52.75 miles below Ellaville), at Branford, was the location of another gauging station which supplied discharge records for that station. Thus stations 13 and 14 have the Ellaville gauge as their reference point, while station 15 has a gauge of its own. This results in stations 13 and 14 having the same discharge so far as this study is concerned. It will be shown below that this is a satisfactory assumption.

The Suwannee receives the contributions of many large calcareous springs. The first known contribution is found a few miles south of the Georgia line, and from that point to almost the mouth there are many springs of various sizes. It is these springs, known and unknown, which are the source of many of the unusual characteristics of the river.

The Suwannee is one of the larger rivers of Florida. There is no total discharge figure available but it appears possible to approximate one. The 22 year mean discharge figure for the Branford gauge is 6536 cfs. The Santa Fe River, which joins the Suwannee below Branford, has a 21 year mean of 1636 cfs. Total volume from known springs equals 420 cfs. This gives a grand total of 8692 cfs, making it the third largest river in the state, only the St. Johns and the Apalachicola having greater mean discharges.

Acknowledgments.—It is a pleasure to express my gratitude to the following for their assistance and cooperation:

Messrs. David B. Lee and J. W. Wakefield, Florida State Board of Health.
Messrs. W. T. Webster, C. J. Smith and W. S. Cummings, National Container Corporation.
Dr. Franklyn C. W. Olson, Florida State University.

METHODS

Samples were taken from the three stations once a month for the above mentioned period. Analytical procedures followed the ninth edition of Standard Methods for the Examination of Water and Sewage with the exception of the determination of hardness for which we used the versenate method. Determination of dissolved oxygen, pH and temperature were made at once. Water samples for other determinations were iced and analyses were made in the laboratory. In no case were these analyses delayed for as much as twenty four hours.

Statistical methods included correlation coefficient (r), the t-test for significance, standard errors (S) and regression formulas. Since all t-values were high and all confidence levels exceeded the 0.99 or most significant level, these values are not tabulated.

DISCUSSION

Discharge-hardness.—The reason for the high negative correlation between these two factors at all stations is not difficult to explain. As was mentioned above, the Suwannee receives the discharge of many springs. "The Suwannee River minimum flow above White Springs is 4.8 second-feet; whereas at Ellaville the minimum discharge is 1,000 second-feet. The total discharge from tributary springs and streams is less than 400 second-feet, which leaves about 595 second-feet that must be discharged from springs into the river along its channel." (Ferguson et al, 1947, p. 17). The main source of hardness is the water from these calcareous springs which have a mean hardness of 174 ppm based on published records (Ferguson et al).

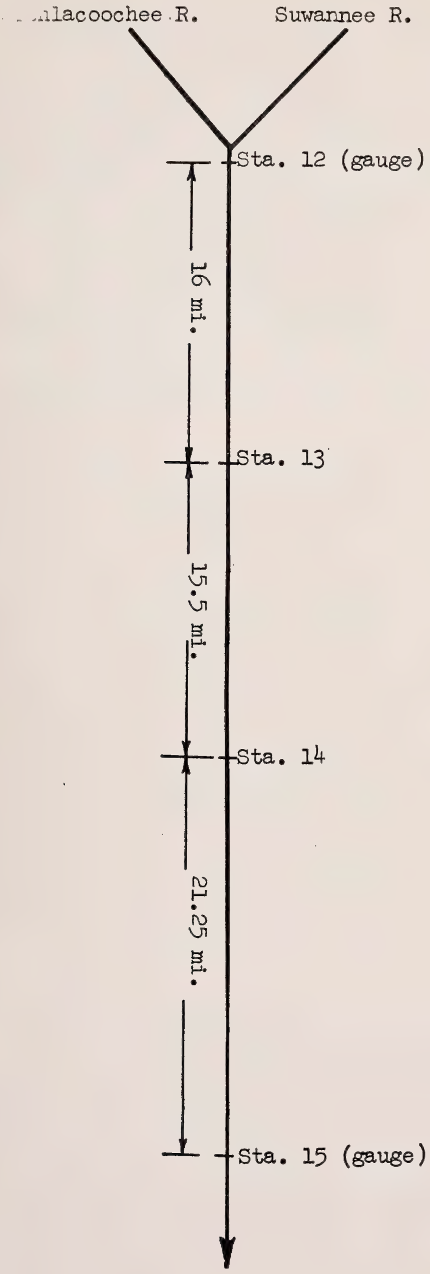


Figure 1. Diagram showing station locations in the Suwannee River.

If discharge is assumed to be zero at station 13 and this is substituted for Q in the equation

$$H = 171 - 0.0184\ Q \qquad (1)$$

the value of H (hardness) is found to be 171 ppm. This may be assumed to be the ultimate hardness at this station as Q approaches zero. By substituting zero for Q in the same equation for station 14

$$H = 174 - 0.0174\ Q \qquad (2)$$

the value of H is 174 ppm. It is considered coincidental that this figure is identical with the mean hardness of the springs in the Suwannee Basin. It is, however, significant that it is close, since these springs are the controlling influence on all pH-allied factors in the Suwannee River proper.

Substitution of zero in the following equation for station 15

$$H = 198 - 0.0174\ Q \qquad (3)$$

gives an ultimate hardness of 198 ppm. It will be noted that the ultimate hardness increases as we progress downstream, in theory as in observation. It is therefor obvious that the increments of spring water increase as the Suwannee approaches the sea.

As Whitford (1956) has pointed out, these springs are of almost constant discharge, while the total stream discharge is highly variable. This results from what might be termed "river water", i.e. swamp drainage, lake drainage and general run-off water, and this in turn might be considered a diluent as opposed to the spring water which is the material being diluted. It naturally follows that the hardness is lowered by dilution as run-off increases and that as the stream discharge decreases the hardness becomes more apparent and represents an actual increase in terms of milligrams per liter.

When we consider that the water leaving the Okefenokee Swamp and that the water in the upper reaches of the Suwannee River is highly acid (the pH may range as low as 4.0) and that the Suwannee at its confluence with the Withlacoochee is essentially a calcareous stream, we realize that great chemical changes have taken place within a comparatively short distance. I have discussed this in greater detail elsewhere (Beck, 1954). It would appear that the spring waters exert more influence than the known volumes would suggest.

Discharge-alkalinity.—From the next discussion it will be seen that alkalinity and hardness are so closely correlated that the above section will suffice for both of these factors.

Hardness-alkalinity.—The correlation coefficients between these two factors are so high as to suggest that they are the same thing. While these two factors are normally closely related in natural waters they are certainly distinct factors. Hardness in water is due to cations (calcium, magnesium, iron and aluminum) and alkalinity is due to certain anions (carbonates, bicarbonates, hydroxides, borates, silicates and phosphates). Both alkalinity and hardness may be present in similar quantities, but this is by no means a constant relationship. From Tables 1, 3 and 5 it will be seen that either factor may be calculated from the other with reasonable accuracy in the Suwannee River.

The regression formulas for these two factors reveal some interesting facts. If we set A (alkalinity) equal to zero at state 13 in the formula

$$H = 11.4 + 1.07\ A \tag{4}$$

a hardness of 11.4 ppm is suggested. Hardness in the Suwannee River always exceeds alkalinity. Substituting zero for H in the following equation

$$A = 0.916\ H - 8.7 \tag{5}$$

gives a negative value for A (−8.7). Since it has been stated above that hardness always exceeds alkalinity, it is obvious that we cannot set hardness at zero in this equation and expect a reasonable answer.

Discharge-color.—High color is associated with high run-off in the Suwannee River. Since run-off water is a combination of swamp drainage, lake drainage and other general surface waters, such water is naturally high in derivatives of the humus layers of the soil. It is the material from the humus layers of the soil which is the source of much of the suspended or dissolved organic material that gives the distinctive color to coastal plain streams in southeastern United States. That there is a positive correlation between discharge and water color is not surprising. In times of low river discharge there is less color for two reasons. There is less humic material leached from the soil of the surrounding terrain, and the colored water present is diluted to a higher degree by the clear spring contributions.

TABLE 1

STATISTICAL DATA, STATION 13

X factor	A factor	r	$S_{X.A}$	$S_{A.X}$	Regression Formulas
Q	H	—0.891	±966	±20	$Q = 8140 - 43.2\,H$ $H = 171 - 0.0184\,Q$
Q	A	—0.908	±893	±17	$Q = 7780 - 47.8\,A$ $A = 149 - 0.0173\,Q$
H	A	0.993	±16	±4.8	$H = 11.4 + 1.07\,A$ $A = 0.916\,H - 8.7$
Q	C	0.893	±960	±45	$Q = 981 + 20.63\,C$ $C = 0.0386\,Q - 10.7$
Q	B	—0.640	±1640	±8	$Q = 4516 - 12.8\,B$ $B = 73 - 0.032\,Q$

TABLE 2

RANGES, STATION 13

	Minimum	Mean	Maximum
Discharge, cfs	1400	3737	7400
Hardness, ppm	50	102	154
Alkalinity, ppm	36	85	133
Color, ppm	16	134	261
Oxygen, % saturation	43	61	75

TABLE 3

STATISTICAL DATA, STATION 14

X factor	A factor	r	$S_{X.A}$	$S_{A.X}$	Regression Formulas
Q	H	—0.899	±622	±18	$Q = 8800 - 46.5\,H$ $H = 174 - 0.0174\,Q$
Q	A	—0.924	±814	±15	$Q = 8190 - 49.2\,A$ $A = 155 - 0.0174\,Q$
H	A	0.977	±8.7	±8.5	$H = A + 18.35$ $A = 0.951\,H - 13.02$
Q	C	0.877	±980	±44	$Q = 1128 + 21.11\,C$ $C = 0.0372\,Q - 15.4$
Q	B	—0.710	±1500	±14	$Q = 1159 - 12\,B$ $B = 81 - 0.042\,Q$

From the tabulated material it will be seen that the results of the regression formulas and the standard errors do not indicate that a very accurate estimate of color based on discharge or of discharge based on color is possible. Although there is a high degree of correlation between the variations in these two factors, the quantitative relationships leave much to be desired. The measurement of color by photometric methods is far from satisfactory. Color and turbidity, particularly when turbidity is normally low in streams like the Suwannee River, are most difficult to separate by any methods short of a recording spectrophotometer. Such equipment was not available for this study.

Use of the regression formulas does reveal some interesting points, nevertheless. By setting Q equal to zero in the following equation for station 13

$$C = 0.0386\ Q - 10.7 \tag{6}$$

the value for C (color) is — 10.7 ppm. The negative value obtained here means little in view of the high standard error (± 45 ppm). Setting C at zero in the equation

$$Q = 981 + 20.63\ C \tag{7}$$

the value for Q is 981 cfs with a standard error of ± 960 cfs. This suggests at a discharge of 981 cfs at station 13, there would be no run-off water and that the entire flow would consist of spring water.

The same calculations for station 14 reveal the following:

At Q equals zero

$$C = 0.0372\ Q - 15.4 \tag{8}$$

C would equal —15.4 at standard error of ± 44. The above remarks are applicable here.

At C equals zero

$$Q = 1128 + 21.11\ C \tag{9}$$

discharge would equal 1128 cfs at a standard error of ± 980 cfs. There is a suggestion here that total spring contributions amount to approximately 1128 cfs.

Calculations for station 15 yield the following results:

At Q equals zero

$$C = 0.0327\ Q - 53.6 \tag{10}$$

TABLE 4

RANGES, STATION 14

	Minimum	Mean	Maximum
Discharge, cfs	1400	3737	7400
Hardness, ppm	55	109	157
Alkalinity, ppm	36	90	137
Color, ppm	14	124	247
Oxygen, % saturation	45	65	84

TABLE 5

STATISTICAL DATA, STATION 15

X factor	A factor	r	$S_{X.A}$	$S_{A.X}$	Regression Formulas
Q	H	—0.849	±1077	±22	$Q = 9530 - 41.6\ H$ $H = 198 - 0.0173\ Q$
Q	A	—0.842	±1097	±20	$Q = 9240 - 45.7\ A$ $A = 172 - 0.0152\ Q$
H	A	0.972	±9.9	±8.8	$H = 8.90 + 1.08\ A$ $A = 0.876\ H - 2.28$
Q	C	0.860	±1060	±40	$Q = 2558 + 22.59\ C$ $C = 0.0327\ Q - 53.6$
Q	B	—0.870	±1000	±5	$Q = 1577 - 16.25\ B$ $B = 90 - 0.047\ Q$

TABLE 6

RANGES, STATION 15

	Minimum	Mean	Maximum
Discharge, cfs	2180	4554	7500
Hardness, ppm	56	120	172
Alkalinity, ppm	43	102	144
Color, ppm	9	90	231
Oxygen, % saturation	53	69	83

C would equal − 53.6 at a standard error of ± 40. The presence of a significant amount of color in this instance suggests the possibility of a definite source of color in some of the springs in the area between stations 14 and 15.

At C equals zero

$$Q = 2558 + 22.59\ C \qquad (11)$$

Q would equal 2558 cfs with a standard error of ± 1060 cfs, a great increase in the amount of spring water. This is obviously a true estimate of the situation when compared with the summaries of discharge data in tables 2, 4 and 7.

Discharge-oxygen.—The relationship between discharge and percent saturation of dissolved oxygen is inverse. The relationship between these two factors is a complex one. If we consider the relationship between discharge and oxygen with regard to time it is inverse: with regard to space it is direct. Insofar as oxygen is concerned, several inter-acting factors are apparent. First we have the dissolved oxygen content of the moving water mass which we may, for the sake of this discussion, consider as a fixed amount. An increase in discharge is generally accompanied by an increase in materials exerting a demand on this oxygen, thus lowering the concentration. Conversely, lowering of discharge lowers the transport of oxygen-consuming materials and results in a return to the normal concentration. Unfortunately, we cannot stop here, no matter how clear or logical these relationships appear. Frequent mention has been made above of the many springs contributing to the flow of the Suwannee. These complicate relationships to a major degree, at least during periods of low flow. Though the waters from these springs generally have no appreciable oxygen demand, they usually have little or no dissolved oxygen and may lower the concentration of oxygen in the stream by dilution. These effects may be summarized for the sake of clarity.

Factors lowering O_2 concentration
  Increased discharge—washed in materials.
  Increased discharge—overcomes effects of spring water.
  Biological activity—metabolism.

Factors increasing O_2 concentration.
  Increased discharge—overcomes ecects of spring water.

Decreased discharge—lowered transport of humus materials.
Turbulence—reaeration.

When we consider the above contributions to complexity, it is rather remarkable that the regression formulas are as accurate as they are. These formulas must be used with a great deal of care, however.

It is interesting to note from the regression formulas that as the discharge approaches zero oxygen approaches — or slightly exceeds — the observed maximum. If we have oxygen approach zero, then the formula suggests that the water would be carrying no oxygen at 11520 cfs at station 13, 11590 cfs at station 14, or 15770 cfs at station 15. There is no reason to suspect that such would be the case.

General relationships.—It has been pointed out above that definite interrelationships exist between several chemical and physical factors in the Suwannee River. Various combinations of factors have been discussed. It would appear that a general application of these methods should be demonstrated. Material for this discussion is presented in table 7. All calculations are for station 14.

If we start with an observed hardness of 157 ppm and substitute in the appropriate formula the figure 135 ppm alkalinity is obtained. This compares very favorably with the observed alkalinity of 133 ppm (standard error ± 8.5). By substituting 135 in the proper regression formula the discharge is obtained. From this discharge both color and percentage oxygen saturation may be calculated. As was pointed out above, color values are the least accurate and general inaccuracies are greatest for the lowest values.

TABLE 7

CALCULATED AND OBSERVED FACTORS, STATION 14

Factor	Observed	Calculated	Standard Error
Hardness	157	——	——
Alkalinity	133	135	±8.5
Discharge	1450	1358	±622
Color	14	42	±44
O_2 % Sat.	77	69	±14

SUMMARY AND CONCLUSIONS

A study was made of the interrelations of a number of factors in the Suwannee River. These factors were stream discharge, hardness, alkalinity, color and dissolved oxygen (expressed as percentage saturation). Statistical methods included correlation coefficient, the t-test for significance, standard error and regression equation.

A striking negative correlation exists between the following:
cfs discharge and ppm hardness
cfs discharge and ppm alkalinity
cfs discharge and % O_2 saturation

A high degree of positive correlation exists between the following:
ppm hardness and ppm alkalinity
cfs discharge and ppm color

By analytically determining any one of the five above mentioned factors, any other of the five may be calculated within the range of usable accuracy. The limits of accuracy for all discussed factors are given.

By using the regression equations, it is possible to predict ultimate values as a companion factor approaches zero, in certain cases.

The Suwannee River consists of two masses of water; a large volume of acid, highly colored, soft water draining swamps, lakes and the soil of the drainage basin and a lesser quantity of virtually colorless, alkaline, hard water emanating from an unknown number of calcareous springs. The relationships herein discussed are the result of the interaction of these two water masses.

Is a set of interrelationships such as is here reported for the Suwannee River unique or are such relationships to be found in any stream in which two distinct water masses are confluent? Published data including both discharge and hardness and/or alkalinity figures do not show these relationships. The data of Pierce (1947) include excellent chemical data from the St. Johns River just below the entry of water from the Oklawaha River. The former (above this confluence) is acid, soft, colored water, and the latter is alkaline, hard, colorless water. Unfortunately, there is no gauge within many miles of Pierce's station in the St. Johns.

It is suggested that similar relationships will be found in any stream in which two distinct water masses are confluent and thoroughly mixed, provided one water mass is variable in quantity and the other is relatively constant.

LITERATURE CITED

BECK, WILLIAM M., JR.
1954. Studies in stream pollution biology, I. A simplified ecological classification of organisms. Quart. Journ. Fla. Acad. Sci., 17 : 211-227.

FERGUSON, G. E., C. W. LINGHAM, S. K. LOVE and R. O. VERNON
1947. Springs of Florida. Florida Geological Survey Bulletin 31 : 1-196.

PIERCE, E. LOWE
1947. An annual cycle of the plankton and chemistry of four aquatic habitats in northern Florida. University of Florida Studies, Biol. Sci. Ser. 4 : 1-67.

WHITFORD, L. A.
1956. The communities of algae in the springs and spring streams of Florida. Ecol., 37 : 433-442.

A LIST OF MAYFLIES FROM THE LOWER APALACHICOLA RIVER DRAINAGE[1]

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The Apalachicola River, formed by the fusion of the Flint and Chattahoochee Rivers at the Georgia-Florida state boundary, brings with it into Florida many species of Ephemeroptera that reach the southernmost extension of their ranges here. The river system has been described by others (La Forge et al., 1925; Cooke, 1939; Alabama Water Improvement Commission, 1949) and will not be redetailed here. Suffice it to say that the Chattahoochee, arising in the southern Appalachians, provides an excellent highway for the southward movement of many aquatic insects. The Flint, which takes its sources in the southern Piedmont of Georgia, is of considerably lesser importance in this respect.

The boundaries selected for the lower Apalachicola were arbitrarily chosen and do not extend beyond the Coastal Plain. The Alabama counties in which that part of the Apalachicola River drainage under consideration is located are Houston, Henry, and Barbour; those of Florida are Calhoun, Gulf, Gadsden, Jackson, and Liberty. As the river system arises mostly in Georgia, the number of counties included is considerably larger than in the two other states. They are Baker, Calhoun, Chattahoochee, Clay, Crisp, Decatur, Dooley, Doughtery, Early, Lee, Marion, Miller, Mitchell, Quitman, Randolph, Schley, Seminole, Stewart, Sumter, Terrell, Webster, and Worth.

In spite of the larger number of Georgia counties listed above, collections were made in only a few of them as the streams may not have been suitable for extensive collecting or were not readily accessible. Nevertheless, it is felt that the records are representative of that portion of the river system lying within the Coastal Plain. Were the report to have been broadened to cover that part of the Chattahoochee running through the Piedmont and mountainous regions of Georgia, the number of species would be far greater. The map (fig. 1) shows that part of the river system treated in this summary.

The following is a list of those places at which mayflies, either immatures or adults, have been collected along with the dates on

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[1] This investigation was supported in part by a research grant, No. G-4058, from the National Institute of Health, Public Health Service.

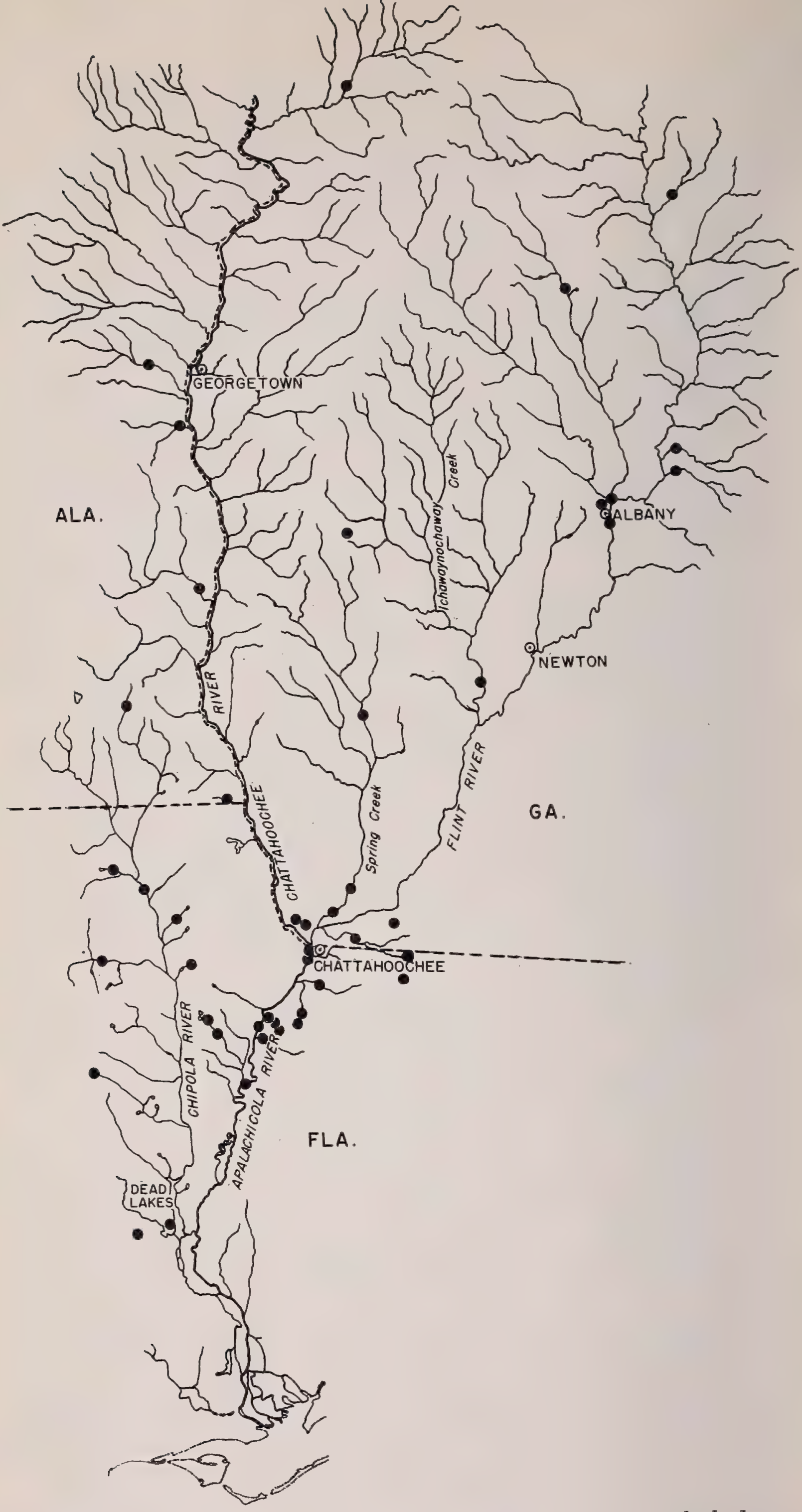

Figure 1. The lower Apalachicola River drainage system. Black dots indicate those places where mayflies were collected.

which collections were made. The majority of the specimens were taken either by me or my assistant, C. D. Hynes.

LOCALITIES

ALABAMA

BARBOUR COUNTY

1. 11.9 miles west of Eufaula at Highway 82: (a) June 22, 1954.
2. 1.7 miles south of junction of Highway 241 with farm road south of Eufaula: (a) June 23, 1954.

HENRY COUNTY

3. 6.2 miles south of Shorterville on farm road: (a) June 23, 1954.

HOUSTON COUNTY

4. Dothan: (a) February 2, 1949.
5. Irwin Mill Creek, Chattahoochee State Park: (a) June 3, 1953.

FLORIDA

CALHOUN COUNTY

6. 4.2 miles east of county line: (a) April 7, 1938.
7. Chipola River: (a) November 5, 1938.
8. 15.1 miles east of Chattahoochee: (a) April 1, 1938.

GADSDEN COUNTY

9. River Junction: (a) March 17, 1939; (b) June 30, 1939; (c) July 1, 1939.
10. Flat Creek, 4½ miles south of Chattahoochee on Highway 269: (a) March 17, 1939; (b) June 30, 1939; (c) July 1, 1939; (d) June 6, 1940; (e) June 8, 1940; (f) April 4, 1953; (g) June 4, 1953; (h) March 20, 1954; (i) June 8, 1954; (j) March 30, 1956; (k) April 13, 1956.
11. Chattahoochee: (a) April 3-4, 1953; (b) June 1-4, 1953; (c) March 20, 1954; (d) June 8, 1954; (e) March 30, 1956; (f) April 13, 1956.
12. Glen Julia Springs near Mount Pleasant: (a) June 6, 1954.

GULF COUNTY

13. 6.9 miles west of Wewahitchka at Highway 22: (a) April 1, 1956.
14. Dead Lakes, 1 mile north of Wewahitchka at Highway 71: (a) April 1, 1956.

JACKSON COUNTY

15. Blue Springs Creek near Marianna at U. S. Highway 90: (a) May 5, 1933; (b) April 13, 1955; (c) December 11, 1937; (d) June 8-9, 1938; (e) July 1, 1939; (f) December 1, 1939; (g) June 5-6, 1940; (h) May 3, 1941; (i) April 18, 1954.
16. 3.6 miles north of Altha: (a) December 10, 1937; (b) June 8-9, 1938; (c) July 1, 1939; (d) December 1, 1939; (e) February 3, 1949.
17. 12.2 miles southeast of Marianna: (a) June 9, 1938.
18. 2.9 miles north of Altha: (a) July 1, 1939; (b) February 3, 1949.
19. 14.2 miles north of Bay County line: (a) June 8, 1938.
20. Florida Caverns State Park: (a) December 2, 1939.

LIBERTY COUNTY

21. Sweetwater Creek near Torreya State Park: (a) May 7, 1933; (b) June 10, 1938; (c) November 4, 1938; (d) July 1, 1939; (e) December 1, 1939; (f) April 8, 1941; (g) May 2, 1941; (h) April 28-30, 1946; (i) May 29, 1946; (j) February 3, 1949; (k) April 14, 1951; (l) June 1, 1953; (m) March 27, 1954.
22. Kelly Branch: (a) December 10, 1937.
23. Little Sweetwater Creek near Torreya State Park: (a) December 10, 1937; (b) June 10, 1938.
24. Crooked Creek about 10 miles south of Chattahoochee: (a) March 17, 1939; (b) July 1, 1939; (c) April 4, 1953; (d) March 20, 1954; (e) March 27, 1954.
25. 4.5 miles north of turnoff to Torreya State Park: (a) June 10, 1938.
26. Alum Bluff on the Apalachicola River: (a) May 3, 1941.
27. Rock Creek, Torreya State Park: (a) June 4, 1953; (b) March 27, 1954; (c) March 30, 1955; (d) March 30, 1956.
28. Bristol: (a) July 29, 1939.

GEORGIA

BAKER COUNTY

29. Ichawaynochaway Creek at Highway 91: (a) April 22, 1949; (b) September 12, 1950; (c) November 27, 1953; (d) May 15, 1954.

CALHOUN COUNTY

30. Cordray's Pond: (a) June 18, 1946.[2]

CHATTAHOOCHEE COUNTY

31. Upatoi Creek at Highway 103: (a) April 11, 1954.

DECATUR COUNTY

32. Mosquito Creek at Highway 97: (a) April 5, 1953; (b) June 5, 1953; (c) March 28, 1954.
33. 1 mile south of Faceville at Highway 97: (a) March 28, 1954.
34. Spring Creek at Reynoldsville: (a) July 1912;[2] (b) July 19, 1912;[2] (c) July 29, 1912;[2] (d) July 16, 1929;[2] (e) August 19, 1939;[2] (f) April 3, 1946;[2] (g) June 8, 1946;[2] (h) June 15, 1946;[2] (i) June 2, 1953; (j) June 8, 1954; (k) August 19, 1954.
35. Spring Creek, 5 miles north of junction of Flint and Chattahoochee Rivers: (a) April 3, 1953.

DOOLEY COUNTY

36. Hogcrawl Creek at Highway 90: (a) November 28, 1953.

DOUGHTERY COUNTY

37. Flint River at Albany: (a) June 22, 1939.[2]
38. Lake Worth near Albany: (a) July 30, 1931.[2]
39. Albany: (a) 1932.[2]

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[2] These records are from the P. W. Fattig collection at Emory University. I am indebted to Dr. W. B. Baker for permitting me to study these collections.

40. 7.2 miles north of junction of U. S. Highway 82 and Highway 257, at Highway 257: (a) November 28, 1953.

MILLER COUNTY

41. Colquitt Spring Creek: (a) June 12, 1931.[2]

SEMINOLE COUNTY

42. Alagar Hole, located between Spring Creek and Chattahoochee River: (a) June 2, 1953.
43. Lewis' Pond: (a) June 2, 1953.

SUMTER COUNTY

44. Muckalie Creek, 1 mile south of Americus: (a) June 20, 1931.[2]

WORTH COUNTY

45. Abram's Creek at Highway 257: (a) November 28, 1953.

LIST OF SPECIES

Superfamily Ephemeroidea

Family Ephemeridae

Hexagenia bilineata (Say)—11 (b); 15 (g); 34 (i); 37 (a); 38 (a).

H. munda elegans Traver—2 (a); 3 (a); 10 (f); 11 (b); 12 (a); 16 (e); 27 (c); 29 (b); 34 (b,d,f,i,j,k); 38 (a); 40 (a).

H. munda marilandica Traver—7 (a); 8 (a); 10 (a,b,i); 15 (h); 16 (c); 21 (a,b,c,e,g,h,j,l,m); 24 (b); 30 (a).

Hexagenia sp.—24 (c); 31 (a); 36 (a); 41 (a); 44 (a).

Pentagenia vittigera (Walsh)—11 (b); 26 (a).

Family Polymitarcidae

Tortopus incertus (Traver)—28 (a); 34 (e); 39 (a).

Superfamily Caenoidea

Family Neoephemeridae

Neoephemera compressa Berner—29 (c).

N. youngi Berner—10 (a,f); 21 (c,e,j,k,m); 24 (a,c,d); 32 (a,c).

Family Caenidae

Brachycercus sp.—29 (d); 34 (i).

Brachycercus sp. A[3]—10 (a); 21 (h,j,k,l,m).

Caenis diminuta Walker—9 (b); 10 (k); 11 (b,d,e); 14 (a); 15 (b,d,e,f,g,h,i); 16 (c); 19 (a); 34 (d,i).

Caenis hilaris (Say)—1 (a); 3 (a); 9 (c); 11 (b,i); 15 (e,g); 16 (d); 21 (b,c,d,e,g,h,j,l); 27 (a); 29 (d); 34 (i).

Caenis sp.—5 (a); 29 (d); 43 (a).

Superfamily Prosopistomatoidea

Family Baetiscidae

Baetisca gibbera Berner—29 (c).

B. obesa (Say)—14 (a).

B. rogersi Berner—2 (a); 10 (a,f); 21 (g,h,j,k); 24 (c,d); 32 (c).

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[3] The species is designated by this letter in *The Mayflies of Florida* (Berner, 1950).

Superfamily Leptophlebioidea
  Family Leptophlebiidae
    Habrophlebia vibrans Needham—16 (a,e); 18 (b).
    Habrophleboides brunneipennis Berner—3 (a); 12 (a); 16 (c); 18 (a,b); 21 (b,g,h,j); 24 (e); 27 (a,b); 32 (c).
    Leptophlebia intermedia (Traver)—4 (a); 9 (a); 10 (a,f,j); 14 (a) 16 (a,d,e); 18 (b); 21 (j); 23 (a); 40 (a).
    Paraleptophlebia bradleyi Needham—36 (a).
    P. volitans McDunnough—16 (a,b,e); 18 (b); 21 (d); 24 (a,c).
  Family Ephemerillidae
    Ephemerella choctawhatchee Berner—10 (a,f); 21 (e,h,j,k,m); 24 (a); 27 (b,c); 32 (c).
    E. hirsuta Berner—21 (k).
    E. rotunda Morgan—11 (c); 27 (d).
    E. simplex McDunnough ? — 27 (c).
    Ephemerella sp. (serrata group)—29 (d).
    Ephemerella sp. A[3]—10 (f); 17 (a); 18 (b); 21 (d,g,k); 24 (e); 32 (a).
    E. trilineata Berner—9 (a); 10 (a,h,k); 13 (a); 14 (a); 16 (e); 18 (b); 21 (c,e,j,m); 23 (a); 24 (c); 31 (a); 35 (a).
  Family Tricorythidae
    Tricorythodes albilineatus Berner—3 (a); 15 (d); 21 (b,c,d,l); 24 (b); 29 (d); 34 (c,i).

Superfamily Heptagenioidea
  Family Isonychiidae
    Isonychia fattigi Traver—10 (a); 11 (b); 17 (a); 21 (b,c,d,e,f); 24 (a); 29 (a,b,c); 34 (i).
    I. pictipes Traver—10 (a,b,d,f,g,i,k); 21 (d,e,g,h,j,k,l); 24 (a,c); 27 (a,b,c); 32 (a,c); 34 (i).
    Isonychia sp.—2 (a); 3 (a); 21 (m); 29 (d); 30 (a); 32 (b); 34 (h); 45 (a).
    Isonychia sp. G[3]—24 (a,c,e); 27 (a,b,c,d); 32 (c).
  Family Heptageniidae
    Heptagenia flavescens Walsh—11 (a); 34 (f,g).
    Heptagenia sp.—1 (a).
    Stenonema exiguum Traver—1 (a); 3 (a); 4 (a); 5 (a); 10 (a,i); 11 (a,b,d); 15 (c,d,e,g,h,i); 16 (b); 17 (a); 21 (b,c,d); 24 (c); 32 (b,c); 34 (i).
    Stenonema interpunctatum (Say)[4]—7 (a); 8 (a); 10 (i); 15 (a,c,d,e,g,i); 16 (b); 21 (h); 25 (a); 29 (c,d); 34 (a,i).
    Stenonema smithae Traver—4 (a); 6 (a); 8 (a); 9 (a); 10 (a,b,e,f,g,i,k); 11 (a,b,d); 15 (a,c,g); 16 (a,b,d,e); 18 (b); 21 (a,b,c,d,e,g,h); 22 (a); 23 (a); 24 (a,c,e); 25 (a); 27 (c,d); 29 (c,d).
    Stenonema sp.—1 (a); 2 (a); 5 (a); 11 (a); 27 (a); 31 (a); 34 (f,g); 45 (a).
    Stenonema varium Traver ?—40 (a); 45 (a).
  Family Ametropodidae
    Siphloplecton speciosum Traver—10 (f).

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[4] This species was referred to as *Stenonema proximum* Traver in *The Mayflies of Florida* (Berner, 1950).

Family Baetidae

Baetis australis Traver—4 (a); 13 (a); 16 (e); 20 (a); 21 (g); 29 (d).

B. ephippiatus Traver—16 (c); 29 (d).

B. intercalaris McDunnough—5 (a); 9 (a); 10 (c,f); 20 (a); 21 (c,d,e,g,i j,l); 24 (a,c,e); 29 (c); 32 (b,c); 45 (a).

B. propinquus (Walsh)—11 (b,d); 15 (e).

B. spiethi Berner—7 (a); 15 (i); 16 (a,b,c,e); 18 (b); 20 (a); 21 (c,d,e,g,h,j); 24 (e); 27 (b); 29 (d); 32 (b,d); 45 (a).

Baetis spinosus McDunnough—3 (a); 5 (a); 9 (a,b); 10 (c,d,f,i); 16 (a,c,e); 18 (b); 20 (a); 21 (c,d,g); 23 (a,b); 24 (a,c,e); 25 (a); 27 (c); 31 (a); 32 (b,c); 40 (a); 45 (a).

Baetis sp.—1 (a); 2 (a); 11 (b); 29 (d); 34 (i).

Callibaetis floridanus Banks—5 (a); 15 (e,f,g,h,i); 20 (a); 35 (a).

Callibaetis sp.—11 (f); 16 (e); 18 (b); 33 (a); 43 (a).

Centroptilum hobbsi Berner—1 (a); 17 (a); 21 (l); 29 (c,d).

C. viridocularis Berner—15 (e); 21 (l); 34 (i).

Cloeon rubropictum McDunnough—20 (a); 29 (d).

Cloeon sp. A[3]—4 (a); 16 (d); 18 (b); 29 (d).

Pseudocloeon punctiventris (McDunnough)—21 (h); 23 (a); 29 (c,d); 31 (a).

P. parvulum McDunnough—21 (b,d).

Pseudocloeon sp.—1 (a); 2 (a); 10 (i); 11 (a).

REFERENCES

ALABAMA IMPROVEMENT ADVISORY COMMISSION

1949. Studies of pollution in streams of Alabama. 297 p., illus.

BERNER, LEWIS

1950. The mayflies of Florida. Gainesville, Univ. of Fla. Press. xii + 267, 88 figs., 24 pls., 19 maps.

1953. New mayfly records from Florida and a description of a new species. *Fla. Ent.* 36(4) : 145-149, 3 figs.

1955. The southeastern species of *Baetisca* (Ephemeroptera: Baetiscidae). *Fla. Acad. Sci., Quart. Jour.* 18(1) : 1-19, 23 figs.

1956. The genus *Neoephemera* in North America (Ephemeroptera: Neoephemeridae). *Ent. Soc. Amer., Ann.* 49(1) : 33-42, 26 figs.

COOKE, C. WYTHE

1939. Scenery of Florida. State of *Fla. Dept. of Conservation,* Geol. Bull. No. 17, pp. 1-118, 58 figs.

EDMUNDS, G. F., JR., and JAY R. TRAVER

1954. An outline of a reclassification of the Ephemeroptera. *Ent. Soc. Wash., Proc.* 56(5) : 236-240.

LaFORGE, L., W. COOKE, A. KEITH, and M. R. CAMPBELL

1925. Physical geography of Georgia. Geol. Surv. of Ga., Bull. 42, pp. 1-189, pls. 143.

CALL DIFFERENCE AS AN ISOLATION MECHANISM IN FLORIDA SPECIES OF HYLID FROGS

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The occurrence of a relatively large number of species of hylid frogs in Florida provides an excellent opportunity to examine the ways in which ethological, as well as other, isolation mechanisms inhibit interbreeding of closely related species. At least 12 species of hylids occur in Florida, and some workers consider there to be 13. Ethological and ecological isolation mechanisms are important in the Florida hylids because they have, with some exceptions, remained sufficiently similar genetically that viable hybrids may be produced by various interspecific combinations (A. P. Blair, 1941; Moore, 1955).

The present discussion will be concerned primarily with difference in mating call as an ethological isolation mechanism. All of the Florida species of hylids lay their eggs in water. The call of the male serves to attract a ripe female, after which amplexus and egg laying occur. Under optimal conditions for anuran breeding, as after a rain, many individuals of several species of the same genus may call from the same breeding pool. Under such conditions attraction of the female to a male of the correct species is highly important lest a mismating result in the production of inviable or disadapted offspring.

Precise measurement and comparison of mating calls is made possible by the use of sound spectrograms. The methods used have been described by Blair and Pettus (1954). Briefly, the technique consists of making tape recordings of the calls in the field and then making a graph of them by use of an electronic instrument (Sona-Graph). The graphs show time versus frequency versus intensity and permit careful comparison of structure and other attributes of the calls.

The present discussion will be concerned with a rather gross comparison of calls among the 12 species of hylids which occur in Florida. There is some individual variation in call within populations, and there is geographic variation in call in some species, but these variations will be discussed in a later report. The differences between species are of such magnitude, both quantitatively and qualitatively, that gross comparisons between species are adequate for our present purposes.

This work has been done under National Science Foundation projects No. NSF G-328 and G-2215. Assistance with the field work has been given by Wayne McAlister, David Pettus, William F. Pyburn and Kirk Strawn. The sound analyses have been made by Wayne McAlister and David Pettus. Recordings of the calls of two species which were not available in my own sound library were kindly made available by Paul Kellogg from the Cornell University Library of Natural Sounds.

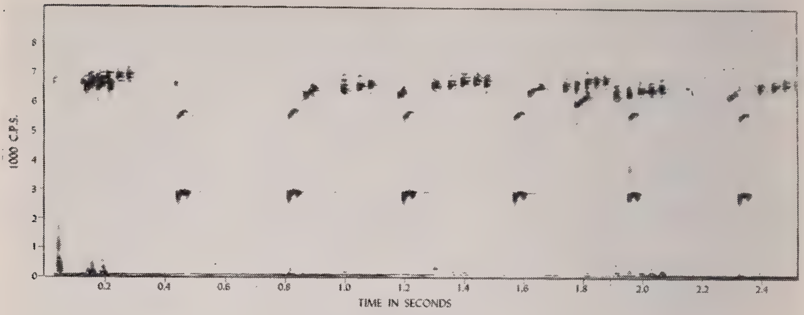
Characteristics of the Calls

Acris gryllus Le Conte.—This widely distributed and very abundant species occurs sympatrically with every other species of hylid frog in Florida. Only inviable hybrids have resulted from attempted crosses between this and other Florida hylids (Moore, 1955). Heterospecific matings involving this species would, therefore, result only in a wastage of gametes of the species involved rather than in the introduction of new genetic variability into either species.

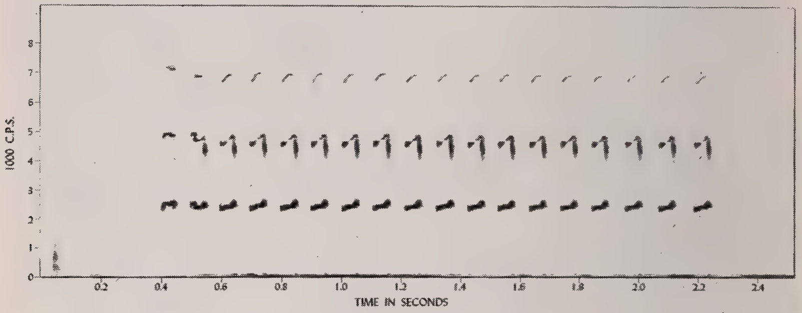
The calls treated here were recorded at Hogtown Sink, Alachua County, Florida, on September 2, 1955. The call is the shortest in duration of any of the Florida hylids, averaging only about 0.04 second (Table 1). A sequence of these calls is usually repeated at intervals of about 0.2 second. Structurally, the call consists of a series of harmonics extending from the fundamental at about 300 cps up to or above 8,000 cps (the upper limit of the Sona-Graph is 8,000 cps). The wave lengths in the vicinity of the thirteenth harmonic (3900 cps) are strongly emphasized (Figure 4).

Hyla crucifer Wied.—This widely distributed species occurs sympatrically with all other Florida hylids except *H. septentrionalis.* It belongs to the medium sized group of hylids. It is largely a winter breeder in the southern states, a habit which it shares with *Pseudacris nigrita* and *P. ornata.* Hybrids between *H. crucifer* and *P. nigrita* have failed to reach metamorphosis (Moore, 1955), and ones between *H. crucifer* and *H. versicolor* have had the same history (A. P. Blair, 1941).

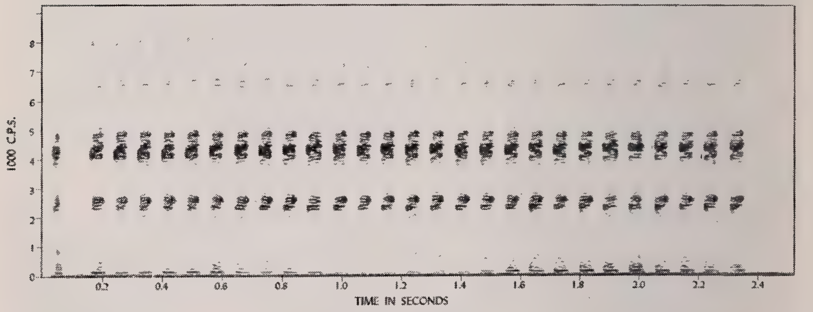
The calls discussed here were recorded in Sam Houston National Forest, Montgomery County, Texas, on January 25, 1954. The call



PSEUDACRIS ORNATA



HYLA PHAEOCRYPTA



HYLA FEMORALIS

Figure 1. Sonagrams of calls of hylid frogs: (1) *Pseudacris ornata,* 6 calls, (markings between 6 and 7 kc represent calls of *Hyla ocularis*); (2) *H. phaeocrypta,* one call; (3) *H. femoralis,* one call.

is fairly short, averaging about 0.14 second, and is repeated at intervals of about 0.8 to 1.0 second. The dominant pattern of the call consists of a band rising from about 2,400 to 2,600 cps and 2 less intense, higher harmonics of this band. This dominant band is actually the second harmonic, and the fundamental (1,200 cps) and third and fifth harmonics are weakly expressed (Figure 2). The dominant band and its harmonics start out as broad bands, then narrow for most of their duration, then broaden at the end. This gives a band pattern that is hooked at each end. The most remarkable feature of the call is a series of transients which begin between the dominant band and its harmonics and coverage on these structures at the end of the call (Figure 2).

Pseudacris ornata (Holbrook).—This winter breeding species occurs sympatrically with all of the other Florida hylids except *H. septentrionalis.* It is one of the medium sized group of hylids. There is no published information concerning crossability of this species with other Florida hylids.

The calls discussed here are from Cornell University Library of Natural Sounds, Cuts No. 1 and 2. The call of this species is very short, averaging about 0.06 second in length. The call is repeated at intervals of about 0.4 second. Only the call of *Acris* is shorter among Florida hylids. The call of *P. ornata* is structurally very similar to the call of *H. crucifer.* There is a series of harmonics ranging from the fundamental at about 850 cps up to at least 8,000 cps, but only the third, sixth, and to a lesser degree, the ninth are emphasized. The emphasized harmonics are structurally similar to those of *H. crucifer,* from which they differ in their shorter duration. There is the same broadening of the band at the beginning and end of the element, and the frequency rises in the course of the call.

Hyla gratiosa Le Conte.—The distribution of this species is sympatric with that of all of the other Florida hylids except *H. septentrionalis.* This treefrog is considerable larger than any other hylid that occurs within its range. Metamorphosis has resulted in crosses between this species and *H. versicolor* (Moore, 1955). Metamorphosis has been obtained in my laboratory in a cross between this species and *H. cinerea.* None of the hybrids has been tested for fertility.

The calls on which the present discussion is based were recorded about 3 miles west of New Augusta, Perry County, Mississippi, on

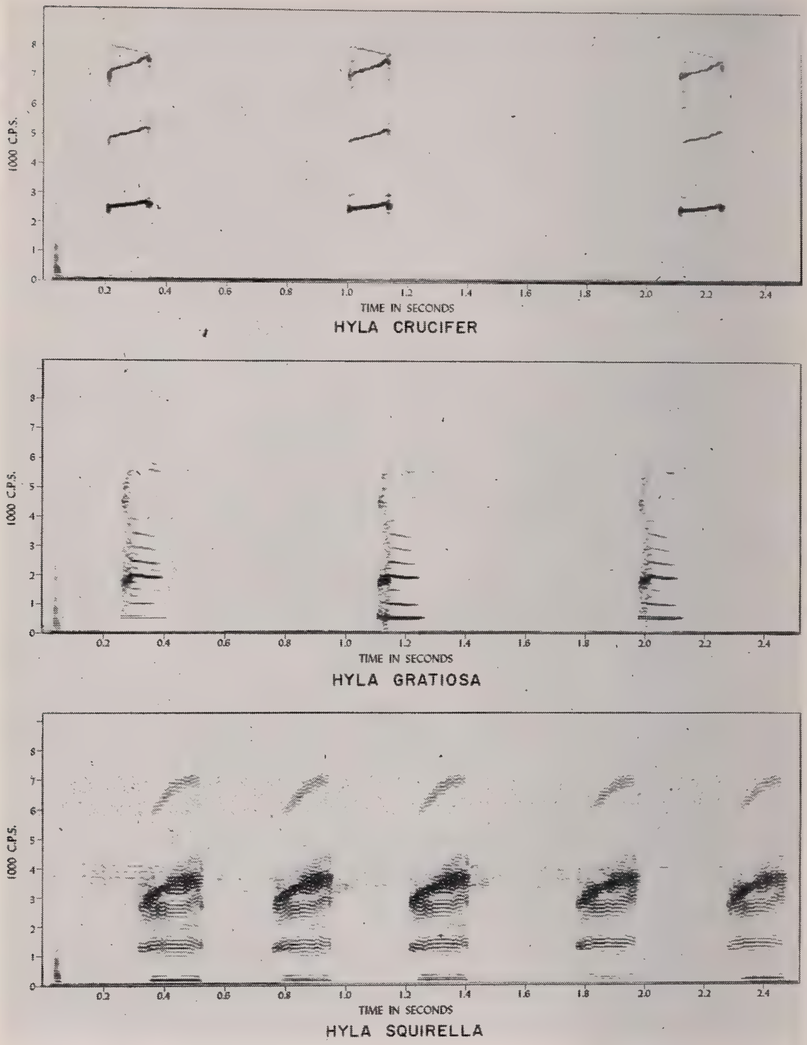


Figure 2. Sonagrams of calls of hylid frogs: (1) *Hyla crucifer*, 3 calls; (2) *H. gratiosa*, 3 calls; (3) *H. squirella*, 5 calls, faint background noise showing at about 4 kc.

July 27, 1956. The call is relatively complex in that the fundamental is changed in the course of the call (Figure 2). In the short initial part of the call the fundamental is about 150 cps., and there is a series of harmonics ranging up to at least 8,000 cps. After about 0.04 second of this, every third harmonic is continued, with the intervening ones being dropped out, so that the third harmonic of the first part of the call becomes the fundamental of the last part at 450 cps. There is a slight drop in frequency in this part of the call. The fundamental of this terminal section of the call is slightly emphasized in relation to its harmonics up through the twelfth. The duration of the total call averages about 0.16 second, and calls are repeated at intervals of about 0.8 second.

Hyla cinerea (Schneider).—This marsh and littoral preferring species occurs sympatrically with all of the other Florida hylids. It is very abundant in its preferred environment and forms huge breeding choruses in permanent or semi-permanent waters. It averages somewhat smaller than *H. gratiosa* but overlaps it in the range of size variation. It produces viable hybrids when crossed with *H. gratiosa* (author's unpublished records).

The calls discussed here were recorded at Welaka, Putnam County, Florida, on September 4, 1954. The call shows similarities in its general structure to the call of *H. gratiosa.* The duration of the call averages about 0.18 second, and the call is repeated at intervals of about 0.7 to 1.1 seconds (Figure 4). The call is like that of *H. gratiosa* in that the fundamental changes after a short initial segment of the call. The fundamental is about 140 cps in this initial part of the call, and there is a series of harmonics up to at least 8,000 cps. After about 0.03 second, alternating harmonics, beginning with the second, are continued and the intervening ones are dropped out. The fundamental of this second part is, therefore, 280 cps. The eleventh and twelfth harmonics (3,080 and 3,360 cps, respectively) are strongly emphasized in relation to the others.

Hyla squirella Sonnini and Latreille.—This species occurs sympatrically with all of the other Florida hylids. It is ecologically tolerant and very abundant on the Gulf coastal plain from eastern Texas to Florida. It is an intermediate sized frog, differing little in size from the majority of the species with which it associates. I know of no published information about crossability of this species with the other Florida hylids.

TABLE 1. AVERAGE VALUES FOR SELECTED ATTRIBUTES OF THE CALLS OF 11 SPECIES OF FLORIDA HYLID FROGS.

Species	Locality	Temperature °C		Number of Individuals	Dominant Frequency (cps)	Duration (seconds)	Repetition Rate (per second)
		Air	H_2O				
A. gryllus	Welaka, Florida	25.0	30.0	1	3914	0.04	——
P. ornata	——	——	——	2	2562	0.06	——
H. crucifer	Huntsville, Texas	20.0	16.0	1	2467	0.14	——
H. gratiosa	New Augusta, Mississippi	25.0	30.0	3	435	0.16	——
H. cinerea	Welaka, Florida	25.0	26.5	3	3407	0.18	——
H. squirella	Welaka, Florida	25.0	26.5	5	3457	0.24	——
P. nigrita	Cedar Key, Florida	26.5	27.0	3	3325	0.39	28.6
H. versicolor	Beaumont, Mississippi	24.5	26.0	9	2444	0.84	46.7
H. femoralis	Otter Creek, Florida	23.0	25.0	3	4800	2.35	12.2
H. phaeocrypta	New Augusta, Mississippi	25.0	30.0	9	4500	1.99	9.7
H. ocularis	Otter Creek, Florida	23.0	25.0	2	7125	0.16	50.0

The calls on which the following discussion is based were recorded at Welaka, Putnam County, Florida, on September 4, 1954. The call is moderate in duration, averaging about 0.24 second (Table 1). The fundamental is low, about 133 cps, and there is a large series of harmonics of the fundamental reaching up to about 7,500 cps. Superimposed on this, there is a pattern of emphasized bands which rise across it and involve short segments of the harmonics of the fundamental. The dominant one of these rising elements starts at about 2,500 cps and rises to about 3,700 cps. A harmonic of this element which rises from about 5,000 to 7,400 cps represents the remnants of the basic harmonic pattern in that region of the frequency spectrum. The call is repeated at intervals of about 0.5 second.

Pseudacris nigrita (Le Conte).—The range of this winter breeding species overlaps the ranges of all of the other Florida hylids. Hybrids from the crossing of female *P. nigrita* with male *H. crucifer* survived through metamorphosis, while hybrids from the reciprocal cross survived to the larval stage (A. P. Blair, 1941). Hybrids resulting from crosses between *P. nigrita* and *H. versicolor* survived to the larval stage (Moore, 1955).

The calls discussed here were recorded about 0.3 mile northeast of the landward end of the Cedar Key causeway in Levy County, Florida, on September 3, 1955. The call of *P. nigrita* is unlike the call of any of the species discussed above in that it is "trilled", i.e., each call consists of a series of individual notes repeated in rapid succession. This is the most widely distributed species of hylid in North America, and there is much geographic variation in repetition rate. In the population sampled, the repetition rate averages 28.6 notes per second. The dominant frequency band is at about 3,325 cps and rises slightly in the course of the call. There is a less emphasized harmonic of this band at about 6,650 cps (Figure 3). The duration of the call averages 0.39 second, and it is repeated at intervals of about 0.9 second.

Hyla versicolor Le Conte.—This widely distributed species occurs with all of the other Florida hylids except *H. septentrionalis.* It is of approximately the same size as *H. cinerea.* Crossing of *H. versicolor* with *H. crucifer* resulted in development to larva, with *H. gratiosa* to metamorphosis, and with *P. nigrita* to larva (Moore, 1955).

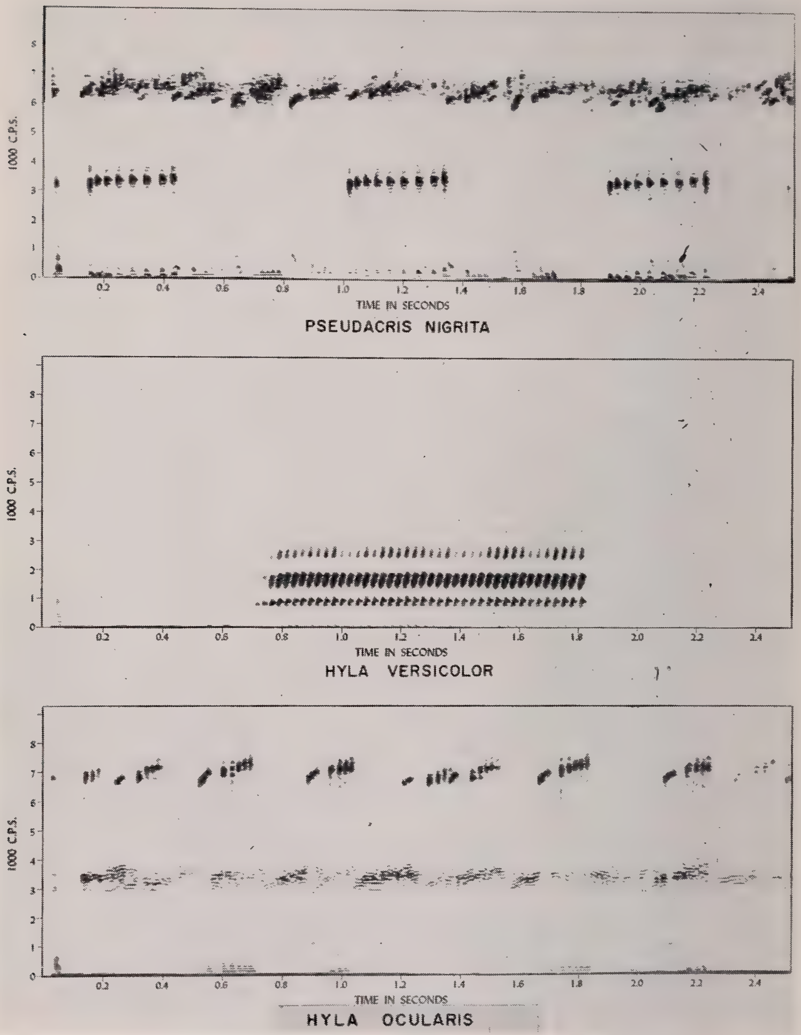


Figure 3. Sonagrams of calls of hylid frogs: (1) *Pseudacris nigrita,* 3 calls, plus *H. ocularis* chorus at 6 to 7 kc; (2) *Hyla versicolor,* one call; (3) *H. ocularis,* series of calls, plus background of *H. squirella* at 3 to 4 kc.

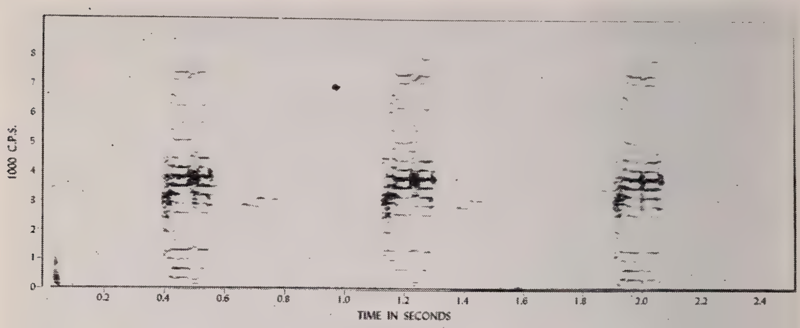
The calls considered here were recorded about 2.6 miles southeast of Beaumont, Perry County, Mississippi, on July 28, 1956. The trilled call is longer than that of all of the other Florida hylids except *H. phaeocrypta* and *H. femoralis.* The duration averages 0.84 second in the individuals analyzed. The repetition rate averages 46.7 notes per second, which is next to the fastest rate of any of the Florida hylids. There is a weakly expressed, very low frequency element. There is a moderately expressed band of about 1225 cps on the average, but as low as 900 cps in some individuals. The next higher band (about 2450 cps) is strongly intensified, and the others are weak to moderately intense (Figure 3). There are weak transient elements between the harmonics. There is virtually no change in frequency from beginning to end of the call.

Hyla femoralis Sonnini and Latreille.—This species has a range overlapping that of all other Florida hylids except *H. septentrionalis.* It belongs to the group of medium sized hylids. There is no information about crossability with other species of Florida hylids.

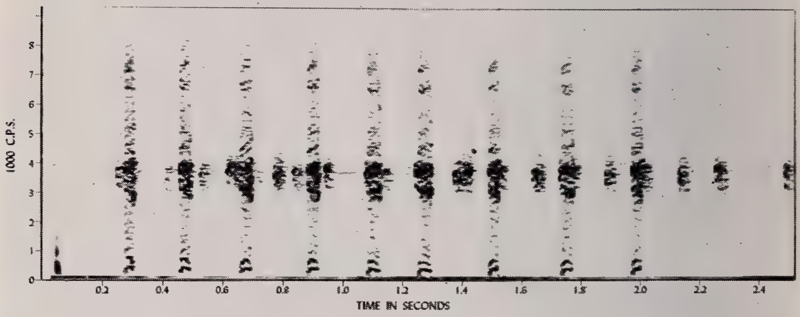
The calls considered here were recorded about 4.4 miles northeast of Otter Creek, Levy County, Florida, on September 2, 1955. The trilled call is the longest of any Florida hylid (Table 1), averaging about 2.35 seconds. The repetition rate averages 12.2 notes per second. The fundamental is about 100 cps. The harmonics of the fundamental are dropped out or very weak except for emphasized bands centering around 200, 2,600 and 4,800 cps (Figure 1). The third (4,800 cps) of these harmonically related, emphasized bands is usually the strongest, but the second (2,600 cps) is sometimes dominant.

Hyla phaeocrypta Cope.—The range of this species overlaps the range of all of the other Florida hylids except *H. septentrionalis.* It is one of the medium sized hylids. There is no information about crossability with other species of Florida hylids.

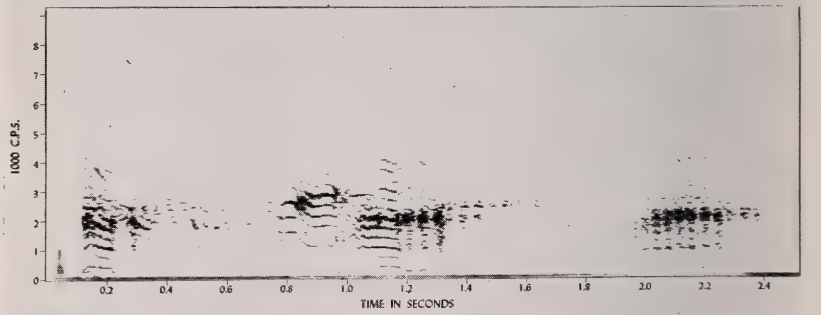
The calls treated here were recorded about 3 miles west of New Augusta, Perry County, Mississippi, on July 27, 1956. The trilled call is next to the longest of any of the Florida hylids (Table 1), averaging 1.99 seconds. The repetition rate is the slowest of any of the Florida hylids, averaging only 9.7 notes per second. In the frequency structure, there is a weakly expressed element at about 100 cps and 3 higher elements, all harmonically related, at about 2,300, 4,500, and 6,700 cps (Figure 1). All of these higher elements



HYLA CINEREA



ACRIS GRYLLUS



HYLA SEPTENTRIONALIS

Figure 4. Sonagrams of calls of hylid frogs: (1) *Hyla cinerea,* 3 calls, faint background noise between 3 and 4 kc and between 6 and 7 kc; (2) *Acris gryllus,* 9 complete calls with elements of background calls of the same species showing between and following them; (3) *H. septentrionalis,* sequence of calls of the type involving a noise-like element and a fast trill.

show a complex form which includes a rise in frequency, followed by a broadening of the wave band. This effect is most pronounced in the element at 4,500 cps, which is also somewhat more intense than the strongly emphasized element at 2,300 cps.

Hyla ocularis Bosc and Daudin.—This tiny treefrog is so much smaller than any of the other Florida species that size alone probably serves as a completely effective isolation mechanism. Its range is sympatric with the ranges of all of the other Florida hylids. There is no information about its crossability with other hylid species.

The calls discussed here were recorded about 4.4 miles northeast of Otter Creek, Levy County, Florida, on September 2, 1955. The outstanding features of the call of this species are the high frequency and relatively complex structure (Figure 3). The call consists of 2 parts, in the first of which there is a rise in frequency from about 6,700 to 7,200 cps over a period of about 0.04 second. After a lapse of about 0.03 second, 4 to 5 notes are rapidly repeated at a rate of about 50 notes per second and with only a slight additional rise in frequency. The total call lasts an average of 0.18 second. There is a weak low frequency element around and above 100 cps. It is likely that there are harmonics of the dominant frequency band above the 8,000 cps limit of our technique.

Hyla septentrionalis Boulenger.—This large, possibly introduced, hylid has a Florida distribution of, "Miami and the lower Keys" (Carr and Goin, 1955). In Florida it occurs sympatrically with *Acris gryllus, Hyla cinerea, H. squirella, Pseudacris nigrita* and *H. ocularis.* Size alone would probably serve as an effective isolation mechanism against all of these except possibly *H. cinerea.* The males become sexually mature at no more than 40 mm. but continue to grow until nearly twice that length (Carr, 1940). Young breeding males would be no larger than breeding male *H. cinerea.* There is no information concerning crossability with the other Florida hylids.

The calls treated here are from Cornell University, Library of Natural Sounds, Cut No. 49-30A-6. The call of this primarily Cuban and Bahamian species is a more variable combination of sonic elements than that of any other Florida hylid. A sequence of individual calls of one type may be repeated at intervals of about 0.9 second. These calls consist of 2 distinct elements. The first element is a noise-like sound, with a fundamental of about 300 cps and a series of harmonics up to about 5,100 cps. The frequency rises and falls in a pattern that varies from call to call of the same individual. The emphasized frequency centers around 2,100 cps at the start and around 2,500 cps at the end of this part of the call. This part lasts about 0.15 second, after which the call changes to a rapid repetition of about 5 to 9 notes in which the harmonic structure is preserved except that the fundamental is now about 150 cps, and intervening harmonics are expressed. The repetition rate varies from 25 to 40 notes per second in this part of the call, which has a duration of about 0.3 to 0.4 second. In some sequences, the calls of this type are separated by a relatively slow repetition of about 5 short notes, which have a duration of about 0.03 second and a repetition rate of about 10 per second. The fundamental in this call is about 105 cps, with harmonics being expressed from about 945 to about 2,560 cps. The lower part of this band is emphasized. The vocal versatility exhibited by this species is very different from the set patterns of call shown by the other Florida hylids.

Discussion

Relationships

The 12 species of hylid frogs in Florida are classified in 3 nominal genera, but there is no good evidence that more than 2 biologically distinct groups of species are represented. The single species comprising the genus *Acris* appears to be distantly related and relatively diverged from the other Florida hylids. Genetic incompatibility and divergence in habit (terrestrial, littoral life) provide the basis for this argument. By extrapolation from the available hybridization experiments between *Acris* and the other Florida hylids, it seems likely that this species need be considered in relation to the other hylids only in terms of possible gamete wastage rather than in terms of possible introgression.

Treatment of *Pseudacris* as a distinct genus probably emphasizes unjustifiably the relatively minor morphological differences between these frogs and those classified in the genus *Hyla* in view of the residual genetic compatibility between them and some species of that genus. Generic separation of species which can be crossed as readily as can representatives of nominal *Pseudacris* and *Hyla* seems biologically unrealistic and indefensible. The generic labels of the species are not important to the present discussion. What is important is the fact that viable hybrids may be produced in various heterospecific combinations regardless of whether the species are in the same nominal genus or not.

Differentiation in Mating Call

The mating call may be differentiated in numerous ways. The most obvious of these are duration and frequency, and repetition rate is another. In addition, there are various ways in which the harmonic structure may vary. The fundamental frequency may differ, and different wave bands may be emphasized in a pattern superimposed on the pattern of harmonics of the fundamental. There may be all degrees of variation from a noise-like call with a long series of harmonics of the fundamental to a musical call with tuning to a narrow wave band and its harmonics.

The 12 species of Florida hylids fall evenly into 2 groups of 6 species with an untrilled call and 6 with a call that is trilled. Comparisons of calls seem necessary only between trilling species and between non-trilling species, as the presence or absence of a trill is an important qualitative difference.

Non-trilling Species.—The call of *Acris gryllus* is the shortest of any of the Florida hylids. It differs from the calls of the other non-trilling frogs in that the long series of expressed harmonics of the fundamental gives it a noise-like quality. The emphasized frequency is higher than that of any of the others of the non-trilling group. This ubiquitous species occurs at times in breeding pools with every other species of Florida hylid.

The two winter-breeding species of non-trilling frogs, *Pseudacris ornata* and *Hyla crucifer,* are largely, but not completely, isolated temporally from the other Florida hylids. The emphasized frequency is lower than that of any of the other non-trilling frogs except *H. gratiosa,* which has a much lower emphasized frequency and a very different distribution of energy through the sound spectrum than any other Florida hylid. The calls of *P. ornata* and *H. crucifer* show certain interesting similarities. The emphasized frequency differs little between the 2, although it represents the second harmonic in *H. crucifer* and the third in *P. ornata.* The most interesting similarity is in the structure of the emphasized band. In both species this band starts as a broad band, narrows, and then broadens at the end. These similarities suggest that someone should investigate further the possibility that these 2 species are more closely related than their present classification in separate nominal genera would indicate. The chief differentiation of the calls of the 2 species is in duration, for the call of *H. crucifer* (0.14 second) is over twice as long as that of *P. ornata* (0.06 second).

Of the 3 remaining, non-trilling species, *Hyla cinerea* and *H. squirella* have very similar dominant frequencies, but the call of *H. squirella* is somewhat longer (0.24 second) than that of *H. cinerea* (0.18 second). In addition to the difference in duration, the calls of the 2 species differ greatly in their harmonic structure. The call of *H. cinerea* has two parts. The short, initial part has a fundamental at 140 cps and harmonics up to at least 8,000 cps, and the longer, second part consists of a continuation of the even-numbered harmonics. The eleventh and twelfth of these harmonics in the second part of the call are strongly emphasized. The call of *H. squirella* has a low fundamental (133 cps) and harmonics up to about 7,500 cps. A pattern of harmonically related emphasized bands rises across this pattern of harmonics of the fundamental. The frequency of these bands rises about 1,200 cps, while there is no frequency change noticeable in the call of *H. cinerea.* The calls of these 2 species, therefore, differ in length, and they differ markedly in their frequency structure.

The call of *H. gratiosa* shows certain basic resemblances to that of *H. cinerea.* The call is similarly made up of 2 parts, of which the second represents harmonics carried through from the first part. In this species every third harmonic of the first part continues in the second part, while it is alternating harmonics that are continued in *H. cinerea.* The structural similarities in the calls of these 2 species suggest the possibility of their rather close relationship. Their calls show little difference in length (0.18 second in *H. cinerea;* 0.16 in *H. gratiosa*). The chief difference betweeen the calls of the 2 species is in the distribution of energy in the frequency spectrum. While the eleventh and twelfth harmonics of the second part of the call are emphasized in *H. cinerea,* the band that becomes the fundamental of the second part of the call is emphasized in *H. gratiosa* and all of its harmonics up through the twelfth are also strongly expressed.

Trilling Species.—The smallest of the trilling species, *Hyla ocularis,* is probably prevented from cross-mating with all of the others by size alone. The frequency of the call, which is unquestionably related to the small size of this frog, is much higher than the dominant frequency of any other Florida hylid. The call differs structurally from all of the other Florida species in having an initial untrilled part separated by a pause from the terminal trilled part, but size of the frog and frequency of the call are probably wholly effective as isolation mechanisms.

The call of *Hyla septentrionalis* differs from that of the other Florida hylids in having a noise-like initial part followed by a trilled part. A different, very slowly trilled call may be inserted in a sequence of calls of this first type. Size alone is probably effective in isolating this species from all of the other species that occur with it in Florida except possibly *H. cinerea.*

Two of the 4 remaining trilling species have calls of moderate length, and 2 have relatively long calls. The first group includes *Pseudacris nigrita* (0.39 second) and *Hyla versicolor* (0.84 second). Temporal isolation probably is largely effective between the winter-breeding *P. nigrita* and the summer-breeding *H. versicolor.* The call of *H. versicolor* is more than twice the length of that of *P. nigrita.* The dominant frequency band in *P. nigrita* is higher than in *H. versicolor.* Although the emphasized frequency varies more in *H. versicolor* than in any other Florida hylid (1,600 to 2,700 cps), the individual with the highest emphasized band in this species is lower than the dominant frequency in *P. nigrita* (3,325 cps). The repetition rate is locally variable in both species. The emphasized band is broader in *H. versicolor* than in *P. nigrita.*

The 2 trilling species with relatively long calls, *Hyla femoralis* and *H. phaeocrypta,* are both summer breeders with approximately the same body size. The call of *H. femoralis* is the longer of the 2, but both have very long calls by comparison with the other Florida hylids. The emphasized frequency is very nearly the same in both species. The greatest differences in the calls of the 2 species are structural. The call of *H. femoralis* is made up of harmonically related emphasized bands, which represent expressed bands of harmonics of the low (100 cps) fundamental. The third of these bands (4,800 cps) is usually dominant, although the second may be in some individuals. There is little energy represented above the level of this third band. The call of *H. phaeocrypta* differs in having 3 strongly expressed bands, of which 2 are comparable in frequency to the emphasized bands of *H. femoralis* and the third is up around 6,700 cps. The dominant band in *H. phaeocrypta* has a complex form involving a rise in frequency followed by a broadening of the band (Figure 1) and the other 2 bands show a rise in frequency.

Although duration and emphasized frequency are quite similar in the calls of these 2 species, the structure of the call gives no suggestion of any close relationship between them.

Summary

The calls of the 12 species of hylid frogs which occur in Florida are compared by use of sound spectrograms, since differences in mating call may serve as isolation mechanisms. The call is trilled in 6 of the 12 species and untrilled in the others. Within these groups, the calls of different species are differentiated in duration, in dominant frequency and in harmonic structure. In the trilling group, there is differentiation in the repetition rate.

The calls of most of the species are strongly differentiated from those of all of the others in at least 2 of the possible variables. The least differentiation is found between the winter breeding *Pseudacris ornata* and *Hyla crucifer,* in which case duration of the call provides the principal difference. Two other species, *Hyla cinerea* and *H. squirella,* which are close together in duration and frequency, have very different harmonic structure. *Hyla cinerea* and *H. gratiosa* which have similar length of call and similarities in harmonic structure differ greatly in distribution of energy through the frequency spectrum.

Genetic incompatibility, body size, and time of breeding are also considered briefly as possible isolation mechanisms.

Literature Cited

BLAIR, A. P.
1941. Isolating Mechanisms in Tree Frogs. Proc. Nat. Acad. Sci. 27 : 14-17.

BLAIR, W. F., and DAVID PETTUS
1954. The Mating Call and its Significance in the Colorado River Toad (*Bufo alvarius* Girard). Tex. Jour. Sci. 6 : 72-77.

CARR, A. F.
1940. A Contribution to the Herpetology of Florida. Univ. Fla. Publ., Biol. Sci. Ser. 3 : 1-118.

CARR, ARCHIE, and C. J. GOIN
1955. Guide to the Reptiles, Amphibians and Fresh-water Fishes of Florida. Univ. Fla. Press, Gainesville, ix + 341, illus.

MOORE, J. A.
1955. Abnormal Combinations of Nuclear and Cytoplasmic Systems in Frogs and Toads. Advances in Genetics 7 : 139-182.

A COMPARISON OF THE NONBREEDING HABITS OF TWO TREEFROGS, *HYLA SQUIRELLA* AND *HYLA CINEREA*

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Even today the vast majority of the characters by which species are described as differing one from another are morphological. This is not so much an indication of the adherence of modern systematists to the old 'morphological' species concept as it is a response to the nature of the material available. These are the characters that are retained by the series of preserved specimens on which systematic studies are necessarily based. Furthermore, they are more readily susceptible to easy and accurate measurement, to statistical treatment, and to clear and precise exposition than are many of the nonmorphological characters which must be studied on living animals. Nevertheless, this emphasis on morphology has tended to obscure the importance of differences in habits and mode of life which may be just as innate, just as valid criteria of species difference, and just as important in the evolutionary history of a group.

For a number of years my husband and I have kept notes on the daily activities of two species of treefrogs, *Hyla cinerea* and *Hyla squirella,* which are found in the mesic hammock area surrounding our home near Gainesville, Alachua County, Florida. Some of our observations have already been published (Goin and Goin, 1953; Goin, 1955). During the fall, winter and spring of 1953-54 we made a more detailed study of the activities of these two frogs with special reference to the relationship between temperature and movement. Late in the summer of 1953 a row of six stakes about four feet high, each with an empty tin can inverted over the top, was set across the eastern end of our yard about fifty feet from the house. This row was parallel to and just at the edge of the woods bordering the cleared area of the yard. These cans, the undergrowth surrounding the yard, and various other situations, both natural and edificarian, in which we know treefrogs are apt to occur, were inspected night and morning from October 22, 1953 to May 31, 1954. Records were kept of the temperatures at the times the cans were inspected, and also of the maximum and minimum temperatures for each twenty-four hour period. Recently we published (Goin and Goin, 1957) an account of our observations on *Hyla squirella* during this period. The present paper deals with a comparison of the activities of *squirella* and *cinerea.*

Comparison of the Species

Hyla squirella and *Hyla cinerea* are quite similar in appearance on superficial examination. They differ most obviously in size and in body build. Specimens of *H. cinerea* average longer [37-59 mm. for breeding male *cinerea,* 23-36 mm. for *squirella* (Wright and Wright, 1949)] but are relatively more slender with proportionately longer legs. Individuals of both species are frequently bright green in color and both have light lateral stripes. The ventral borders of these stripes are indistinct in *squirella,* sharply marked in *cinerea.* The dorsum of *squirella* may be mottled or marked with irregular blotches or flecks; specimens of *cinerea* are never mottled but frequently have a number of minute, black-bordered, golden yellow dots scattered over the head and dorsum. Both species are metachrotic, *squirella* more so than *cinerea.* A *squirella* may be various shades of either green or brown while a *cinerea* is almost always some shade of green from dark olive to very light silvery.

These two species have essentially the same range, occurring throughout the southern coastal plain and lower Mississippi Valley, although *squirella* is not found so far north as is *cinerea.* The range of *squirella* is wholly contained within the range of *cinerea.* During the fall, winter and spring months the frogs inhabit wooded areas often at considerable distances from water. Both forms are summer breeders, but *cinerea* utilizes large permanent ponds and lakes while *squirella* frequently breeds in temporary pools, ditches and flooded grassy flats. *H. cinerea* lays its eggs "in small packets or films at or near the surface, attached to floating vegetation" (Wright and Wright, 1949, p. 305). The eggs of *squirella,* on the other hand, are laid singly on the bottom.

Age Distribution of Hammock Population

One of the most striking differences between the populations of *H. squirella* and *H. cinerea* present in the study area in the fall, winter and spring of 1953-54 was the age distribution of the two species. Out of a total of 1035 observations on *squirella,* 888, or approximately 86%, were of immature individuals which had obviously metamorphosed the previous summer. On the other hand, only 2 immature *cinerea* were seen in the yard during the course of the study, although 471 observations were made of adult *cinerea*. It must be emphasized that these figures do not indicate the number of individual frogs present in the area since many of the observations were of single frogs seen day after day. The greatest number of immature *squirella* seen on a single day was 17, the greatest number of adult *squirella* 3, and the greatest number of *cinerea* 6. The preceding summer had been an unusually wet one and had apparently been an exceptionally favorable breeding season for *squirella*. Nevertheless, there had not been a reproductive failure by *cinerea* during the summer for a visit to a breeding area during the winter revealed the presence of many immature *cinerea* on the water plants and bushes surrounding the lake. Apparently young *squirella* move away from the breeding ponds shortly after metamorphosis, while young *cinerea* tend to remain close to the spawning areas during their first winter. This is probably correlated with the tendency of *squirella* to use temporary breeding ponds which dry up after the end of the summer rainy season.

Seasonal Fluctuations in Numbers

Adult *squirella* and *cinerea* leave the hammock in the spring to move to the breeding areas. They return rather abruptly in late September. We have a few scattered records for late August and early September. After September 18, we saw *cinerea* nearly every day and *squirella* after September 26. Table 1 shows the monthly fluctuation in number seen per day from the last week in October through May. *H. cinerea* were most numerous in November. Their numbers declined in December, then remained nearly constant until the frogs began to move from the yard late in March. By the end of the first week in April, all had left. Young *squirella* did not reach their peak until December. They declined in number through the spring, but were still present when the study was terminated at the end of May. We seldom see *squirella* in the yard during the summer rainy season but frequently hear the rain call given from the trees. This rain call is uttered sporadically in humid weather and is quite distinct from the call in the breeding choruses. It seem possible that yearling *squirella* do not go to the breeding ponds with the adults in the spring but instead move higher up in the trees where they escape observation. The total number (147) of observations on adult *squirella* during the study period was so small that the figures for them should be interpreted with extreme caution. The frogs seem to have been most numerous during February and early March. Apparently adult *squirella* tend to climb higher in the trees than do *cinerea* and so are more apt to escape observation. They are the ones that get on the roof of the house and fall down the chimney. They cling to the under sides of the oak leaves during the day and it is when the old leaves fall in February that we are most apt to find adult *squirella* in the yard. Like *cinerea* they leave toward the end of March. Only one was seen in the last eight days of March and none in April. The ten records for May are probably all observations on a single individual.

Diurnal Site Selection

Frogs of both species spend the day resting and, except during spells of cold weather, move out at night to feed. They show a marked tendency to return day after day to the same resting place. Our previous studies have indicated that this tendency is more strongly developed in *squirella* and that *cinerea* are somewhat more apt to move during the day. A more obvious difference is that *squirella* almost always choose protected sites, in, under or behind something, while *cinerea* are found in much more exposed situations. Thus members of both species may be found resting in the grooves of palmetto leaves, but a *cinerea* will be out in plain view while a *squirella* will be hidden under a dead sweetgum or water oak leaf caught by its stem in a notch of the palmetto frond. Table 2 shows the daytime resting places utilized by *cinerea*. Among the edificarian situations, the 'tool box' is an open wooden packing box near the back door. The *cinerea* were observed most frequently resting on the handle of an axe leaning against a corner of the box. The 'rack' is a metal stand for a fuel oil tank against the back of the house. The 'pipe' is an iron pipe an inch in diameter, with one end angled upward to a height of about 15 inches, lying on the ground behind can No. 3. The frogs rested inside the cavity of the pipe, generally close to the upper rim but moving further down in cold weather. The 'light meter' is fastened to the wall of the house about 7 feet up near the back door. Probably all of the records for the meter represent a single individual which spent the day sometimes

TABLE 1

AVERAGE NUMBER OF FROGS SEEN PER DAY

	Oct. (last week)	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
H. cinerea ad.	2.4	4.3	2.8	2.9	2.7	2.2	*	0
H. squirella im.	2.4	6.0	7.65	4.8	3.4	3.3	2.2	2.4
H. squirella ad.	1.0	.7	.3	.9	1.6	.8	0	.3

* 6 *cinerea* were seen during first week in April but none thereafter.

TABLE 2

DAYTIME RESTING SITES SELECTED BY ADULT *H. CINEREA*

	Oct. (1 week)	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total
Edificarian									
Can # 2	4	2	—	—	—	2	—	—	8
Can # 3	—	—	1	2	—	—	—	—	3
Can # 5	3	10	—	1	—	5	4	—	23
Can # 6	5	1	—	1	—	1	—	—	8
Tool Box	—	10	11	7	12	10	—	—	50
Rack	—	4	4	13	11	13	2	—	47
Pipe	—	—	4	21	26	21	—	—	72
Light meter	—	9	3	—	—	—	—	—	12
Miscellaneous	1	12	5	—	—	—	—	—	18
Total edificarian	13	48	28	45	49	52	6	—	241
Natural									
Palmetto	5	32	26	34	11	12	—	—	120
Little oak	1	34	11	—	—	—	—	—	46
Vine	—	14	7	1	10	1	—	—	33
Holly	—	—	1	3	4	2	—	—	10
Magnolia	—	—	15	6	—	—	—	—	21
Day lily	—	—	—	—	1	—	—	—	1
Total natural	6	80	60	44	26	15	—	—	231

on the top of the meter itself and sometimes a few inches out on the wire leading to the meter. Of the natural situations, 'palmetto', 'little oak' and 'vine' each represent a number of situations at the edge of the thicket bordering the yard. The 'holly' is a single small tree standing in a rather isolated position in the yard about five feet from can No. 3. The 'magnolia' is a sapling near the center of the yard. The 'day lily' is in a small bed by the south side of the house.

The frogs utilized edificarian and natural situations about equally although there was some seasonal variation. In the fall they showed a preference for natural situations, but the number found in such sites declined steadily throughout the winter and spring. The number found in edificarian situations remained relatively constant until the frogs left the hammock in April. The most preferred location was palmetto leaves. Approximately ¼ of the observations (120 out of 472) were of frogs on palmettos. Similar data for *H. squirella* have already been published (Goin and Goin, 1957).

Table 3 shows a comparison of the daytime resting sites utilized by adult *cinerea,* immature *squirella* and adult *squirella.* It is apparent that adult *squirella* show a very strong preference for edificarian sites. Ninety-six percent of the observations were on frogs in such situations. The preferred site was the metal rack for the fuel oil tank. Immature *squirella* chose the cans to a much greater extent than did the adults of either species. Nearly half (48%) of the observations were of frogs in the cans. They showed some preference for edificarian sites but it was much less marked than in the adults.

An even greater difference is shown if the resting sites are classified according to proximity to the house. Ninety-three percent of the adult *squirella* were found on or close to the house in situations which allow easy access to the lighted windows where insects congregate at night. Only twenty-seven percent of the *cinerea* and three percent of the immature *squirella* were found in such situations. This may reflect a difference in feeding habits, with adult *squirella* showing a preference for more strongly flying insects which are attracted to the lighted windows while immature *squirella* and, to a less extent, adult *cinerea* feed on forms more characteristically found on the ground or shrubby understory of the hammock. In a study of the food habits of *cinerea* in the Gainesville region Kilby (1945) found that "Most of its insect prey consists of species of the shrub and herb strata, again reflecting its habits since the frog itself is largely confined to these situations." Again he says, "In the frog populations of the hammocks spiders are eaten in greater numbers and constitute a greater proportion of the bulk of the food than any other group of animals." Dr. Kilby informs me (oral communication) that a few specimens of *squirella* examined during the course of the study contained insects characteristic of the upper story of the hammock.

TABLE 3

DAYTIME RESTING SITES SELECTED BY ADULT *H. CINEREA*, IMMATURE *H. SQUIRELLA* AND ADULT *H. SQUIRELLA*

	cinerea ad.	*squirella* im.	*squirella* ad.
Edificarian			
cans	9%	48%	3%
rack	10%	3%	64%
pipe	15%	10%	0%
other	17%*	1%	29%*
Total edificarian	51%	62%	96%
Natural			
palmetto	25%	9%	1%
holly	2%	17.5%	3%
oak	10%	6%	0%
other	12%	5.5%	0%
Total natural	49%	38%	4%

* All on or near the house.

REACTION TO TEMPERATURE AND HOMING

The winter months in the Gainesville region are characterized by rather extreme fluctuations in temperature. Usually a warm spell of ten days to two weeks, with the minimum diel temperature in the fifties or sixties, will be ended by the arrival of a cold front marked by a sudden drop in temperature. Cold spells do not normally last more than three or four days. Minimum temperatures during these spells are frequently in the low thirties and frost is common. Usually the minimum temperature is recorded around 7:00 A. M. The winter of 1953-54 was not marked by any exceptionally low temperatures (29° was the lowest recorded in our back yard) but was unusual in that the warm spells were of much shorter duration than normal and the cold spells more frequent. During December and January there was a marked temperature drop, with the minimum temperature of one day more than ten degrees below the minimum of the preceding day, on the average of once every six days. For example, on the morning of January 11 the low temperature was 57°, on January 12 it was 32°. Low temperature the morning of December 13 was 69°, it was 55° on the 14th and 33° on the 15th. The point at which the frogs are completely immobilized by cold was not determined, but two young *squirella* were seen moving into a can one evening when the thermometer stood at 44°. Temperatures at which the frogs are normally active at night occurred frequently throughout the winter and there was no definite period of hibernation.

Tables 4, 5 and 6 show the response of the three groups of frogs, *cinerea,* immature *squirella* and adult *squirella,* under different temperature conditions. In the tables the temperatures are those recorded when the sites were inspected in the evenings. The 'number' represents the individual frogs observed to be occupying the various sites during the day. The 'number out' is the number of sites occupied during the day which had been vacated when inspected in the evening and the 'number returned' is the number which were again occupied the next morning.

These figures must be interpreted with extreme care. Any attempt to study a population of animals under natural conditions implies that no effort is made to control variables since it is impossible to make such an effort without altering in some way the natural conditions. We recognize, of course, that the mere presence of the house, the cans, and the yard clearing all constitute disturbances of the natural environment, but we have tried to keep such disturbances at a minimum. Uncontrolled variables in this study include total population size at various times, predation, food supply, the number of nights falling within the various temperature ranges, and other weather conditions such as humidity, rainfall and barometric pressure. The frogs were not marked. Many of the sites selected as daytime resting places, particularly by *squirella,* are such that it would be necessary to remove, or at least seriously

TABLE 4

ACTIVITY OF *H. CINEREA* IN RELATION TO TEMPERATURE

Temp.	No.	No. Out	% Out	No. Returned	% Returned
34-38	7	1	14	0	0
39-43	29	3	10	0	0
44-48	61	2	3	0	0
49-53	97	23	24	8	35
54-58	62	36	60	24	67
59-63	104	86	83	41	48
64-68	75	72	96	24	33
69-73	21	21	100	2	10
Total	456	294	54	99	36%

TABLE 5

ACTIVITY OF *H. SQUIRELLA* IM. IN RELATION TO TEMPERATURE

Temp.	No.	No. Out	% Out	No. Returned	% Returned
34-38	5	3	60	0	0
39-43	40	15	38	2	13
44-48	100	30	30	12	40
49-53	140	71	51	49	69
54-58	118	98	83	58	59
59-63	183	173	95	107	62
64-68	200	199	99.5	106	53
69-73	65	65	100	35	54
Total	851	654	77	369	56%

TABLE 6

ACTIVITY OF *H. SQUIRELLA* AD. IN RELATION TO TEMPERATURE

Temp.	No.	No. Out	% Out	No. Returned	% Returned
34-38	3	0	0	—	—
39-43	8	1	13	0	0
44-48	20	2	10	2	100
49-53	36	18	50	12	67
54-58	20	12	60	7	58
59-63	31	30	97	17	57
64-68	14	14	100	6	43
69-73	6	6	100	3	50
Total	138	83	60	47	57%

disturb, the frogs in order to read any marks. Previous studies had indicated that such disturbance reduces the tendency of the frogs to return to the same sites day after day. We were able to recognize some of the frogs by individual peculiarities of marking, but it was not always possible to say that a frog seen in a given place one day was the same as the frog seen in the same place on the previous day. The failure of a frog to return in the morning may indicate that it simply chose a different resting place, or that it fell victim to some predator while out foraging, or, especially during the late spring when many of the higher temperatures were recorded, that the frog had departed from the hammock in the annual migration to the breeding ponds. Furthermore, the age composition of the populations of the two species must be born in mind. The differences in behavior indicated between *cinerea* and immature *squirella* may result from age rather than from specific differences. The records for adult *squirella* are too few for much reliance to be placed on them, though they do lend support to the interpretation that some of the differences are specific.

With this *caveat* clearly in mind, it is still possible to draw some tentative conclusions from the figures in the tables. Immature *squirella* were more often out at night than were the adults but both young and adult *squirella* were more often out than *cinerea*. *H. squirella* show a greater tendency to return to the same site the following day and there is no indication that age is a factor in return. While we were gathering the data for this study we formed the impression that the frogs tended to move from their accustomed sites to more sheltered spots with the approach of a cold front. This impression is confirmed by the figures. A larger percentage of the frogs were gone when the temperatures in the evening had dropped below 44° than when it was between 44° and 48°. Frogs that moved out during periods of low temperature were much less apt to return. Of the twenty-three frogs that left before the lowest temperatures were recorded, only two immature *squirella* had returned the next morning. Fewer frogs moved out at temperatures between 44° and 48° than in any of the other temperature ranges. Above this point, the number of frogs active in the evening increased steadily as the temperature rose. *H. cinerea* were apparently less apt to return at the lower temperatures than were *squirella*. For *squirella* the largest percentage of returns took place at the temperature range of 49° to 53° while for *cinerea* most returns were recorded in the 54° to 58° range. Returns for *squirella* were fairly constant in both young and adults at the higher temperatures but declined sharply for *cinerea* as temperatures rose.

DISCUSSION

It is unusual in amphibians to find two species of one genus so closely similar in appearance, in habits, and in habitat requirements occupying essentially the same range. The relatively minor differences observed in the habits of these two frogs suggest the possibility that they evolved under different environmental conditions and have subsequently come to occupy the same habitat. The tendency of *squirella* to utilize temporary pools for spawning and the fact that the young move away from the breeding ponds shortly after metamorphosis may indicate evolution in a rather arid environment. The sheltered, edificarian, diurnal resting places may be substitutes for the rocky crevices of their original home. On the other hand, the preference of *cinerea* for the shrubby undergrowth of the hammock, its utilization of permanent ponds and lakes for breeding and the tendency of the young to remain close to the breeding sites after metamorphosis indicate evolution in a humid environment. The homing instinct seems to be somewhat better developed in *squirella* than in *cinerea*. In an arid environment, daytime resting sites providing protection from desiccation and from predation for a non-burrowing form would probably be highly localized. The ability to return to a favorable site once it had been found would have a higher selective value under such conditions than it would in a humid forest environment where suitable sites are wide-spread and readily available. It is possible that the affinities of *H. squirella* are with some of the Hylas of the Southwest or Mexico while *H. cinerea* is eastern in origin. Any such conclusion, however, must await anatomical and paleontological studies.

LITERATURE CITED

GOIN, COLEMAN JETT, and OLIVE BOWN GOIN

1953. Temporal variation in a small community of amphibians and reptiles. Ecology, vol. 34 (2) : 406-408.

1957. Remarks on the behavior of the Squirrel Treefrog, *Hyla squirella*. Annals Carnegie Museum, vol. 35, article 3, pp. 27-36.

GOIN, OLIVE BOWN
1955. World Outside My Door. The Macmillan Company, New York. Pp. vii + 184.

KILBY, JOHN DAVIS
1945. A biological analysis of the food and feeding habits of two frogs, *Hyla cinerea cinerea* and *Rana pipiens sphenocephala.* Quart. Jour. Florida Acad. Sci., vol. 8 (1) : 71-104.

WRIGHT, ALBERT HAZEN, and ANNA ALLEN WRIGHT
1949. Handbook of Frogs and Toads of the United States and Canada. Comstock Publishing Company, Ithaca, New York, 3rd edition. Pp. xii + 640, 126 pls. 37 maps.

Quart. Journ. Fla. Acad. Sci., 21(1), 1958.

COMMENTS UPON THE ORIGIN OF THE HERPETOFAUNA OF FLORIDA

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The fauna of Florida, with its relatively large number of endemics, has been a perennial source of stimulation to zoogeographers. Because of this it would seem that the origin of the Floridian fauna would long ago have been adequately discussed. It seems to me that there are two basic reasons why this is not so. One is the continuing growth in our knowledge of the geology of Florida and the other is the accumulation of new fossil material from Florida. Dr. Robert O. Vernon (1951) gives, for example, a somewhat different interpretation of Cenozoic land masses in Florida than does Cooke (1945). Also, recent studies in Floridian paleontology (see Tihen, 1951; Goin and Auffenberg, 1955; Auffenberg, 1956a, 1958) throw additional light on the early herpetofauna of Florida. Since we now have this additional knowledge of the Cenozoic amphibians and reptiles and these new interpretations of the land masses, it might be profitable to re-examine ideas concerning the zoogeographic relationships of the present Florida herpetofauna.

An examination of the recent amphibians and reptiles of Florida shows that on the basis of geographic affinities they can be divided into five more or less distinctive groups. These are:

Tropicopolitan
Antillean
Northeastern
Southwestern and Mexican
Southeastern and Floridian

These will be discussed in order.

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[1] This paper is an outgrowth of one presented several years ago in a symposium on the origin of the fauna and flora of Florida at a meeting of the Florida Academy of Science. At the time I was revising it for publication my friend, Wilfred T. Neill, of Ross Allen's Reptile Institute, independently began work on his study "Historical Biography of Present-day Florida." His paper has since been published as a Bulletin of the Florida State Museum, Vol. 2, no. 7, pp. 175-220, 1957. Since he emphasized the ecological, while I have emphasized the geological, aspects, however, the two papers tend to supplement one another.

I wish to acknowledge my indebtedness to my colleague, Dr. Walter Auffenberg, for the help he has given me in the preparation of this paper.

Tropicopolitan

This group contains no amphibians and only seven genera of reptiles. They are:

Salamanders	0
Frogs	0
Crocodilians	1
Crocodylus	
Turtles	5
Chelonia	
Eretmochelys	
Caretta	
Lepidochelys	
Dermochelys	
Lizards	1
Hemidactylus	
Snakes	0

As can be seen, this group comprises primarily the large marine turtles and the marine crocodile. The genus *Hemidactylus* is now wide-spread throughout the tropics of both the Old and New World. It extends from northwestern India westward into eastern Africa, south at least to Kenya, along the coast of the Red Sea and the coastal islands of the Mediterranean; in the New World it is found in the West Indies and in Key West and the Miami region of Florida. There is nothing about this group that deserves special comment.

Antillean

This small group contains forms that have reached Florida from the Antilles. It includes one frog and four lizards.

Salamanders	0
Frogs	1
Eleutherodactylus	
Crocodilians	0
Turtles	0
Lizards	4
Gonatodes	
Sphaerodactylus	
Anolis	
Leiocephalus	
Snakes	0

The genera in the above list are unquestionably of Antillean derivation. *Anolis* was present in the Pleistocene of Florida. *Eleutherodactylus, Gonatodes, Sphaerodactylus* and *Leiocephalus,* on the other hand, probably arrived here in post-Columbian times. Like the first group, this one does not really require much comment.

Northeastern

As might be expected, a large portion of the genera of amphibians and reptiles that now occupy Florida are southern extensions of populations occupying the eastern United States. The following list includes those forms that seem to me simple derivatives of northeastern genera.

- Salamanders 7
  - *Necturus*
  - *Diemictylus*
  - *Ambystoma*
  - *Plethodon*
  - *Eurycea*
  - *Pseudotriton*
  - *Desmognathus*
- Frogs 3
  - *Acris*
  - *Pseudacris*
  - *Rana*
- Crocodilians 0
- Turtles 6
  - *Sternotherus*
  - *Chelydra*
  - *Chrysemys*
  - *Malaclemmys*
  - *Graptemys*
  - *Trionyx*
- Lizards 0
- Snakes 7
  - *Carphophis*
  - *Opheodrys*
  - *Elaphe*
  - *Natrix*
  - *Storeria*
  - *Haldea*
  - *Sistrurus*

Examination of this list shows that the genera are basically of two sorts: those like *Necturus, Pseudotriton* and *Acris* that are found only in eastern United States; and those like *Rana, Trionyx* (*sensu latu*), *Elaphe* and *Natrix* that are present in both the Old and the New World but in the New World are restricted largely to the eastern United States. There are two notable things about the above list. One is the predominance of salamanders, which seems to bear out the contention that the eastern United States has been a center of late evolution for this group. The other is the abundance of small natricine snakes which supports the conclusion of Dunn (1931) that the natricines belong to the group which he calls the "Old Northern".

Southwestern and Mexican

This group includes those genera that presumably came in from the west to occupy Florida. The list is as follows:

- Salamanders 0
- Frogs 4
  - *Scaphiopus*
  - *Bufo*
  - *Hyla*
  - *Microhyla*
- Crocodilians 0
- Turtles 4
  - *Kinosternon*
  - *Terrapene*

- *Pseudemys*
- *Gopherus*

- Lizards 6
  - *Sceloporus*
  - *Ophisaurus*
  - *Phrynosoma*
  - *Cnemidophorus*
  - *Lygosoma*
  - *Eumeces*
- Snakes 12
  - *Diadophis*
  - *Heterodon*
  - *Coluber*
  - *Drymarchon*
  - *Pituophis*
  - *Rhadinaea*
  - *Lampropeltis*
  - *Thamnophis*
  - *Tantilla*
  - *Micrurus*
  - *Agkistrodon*
  - *Crotalus*

Florida has a relatively small lizard fauna, but such lizards as are present are basically either forms from the West or introduced Antillean and Tropicopolitan forms plus a few arenicolus genera to be discussed later. Among the snakes it might be noted also that the Florida snake population that has apparently been derived from western stock contains a large percentage of big snakes, such as *Coluber, Drymarchon, Pituophis, Lampropeltis, Agkistrodon* and *Crotalus,* in contrast to the small snakes of the previous list, *Carphophis, Storeria, Haldea, Sistrurus.*

Southeastern or Floridian

- Salamanders 4
  - *Amphiuma*
  - *Manculus*
  - *Siren*
  - *Pseudobranchus*
- Frogs 0
- Crocodilians 1
  - *Alligator*
- Turtles 2
  - *Macroclemmys*
  - *Dierochelys*
- Lizards 2
  - *Neoseps*
  - *Rhineura*
- Snakes 6
  - *Abastor*
  - *Farancia*
  - *Stilosoma*
  - *Cemophora*
  - *Seminatrix*
  - *Liodytes*

Except for the addition of forms more widely distributed in the Southeast, such as *Amphiuma, Siren, Deirochelys, Abastor* and *Farancia,* this is not too different from the list of endemic genera given by Carr (1940). It is this list that contains the forms that we now want to examine in the light of modern geologic interpretations and paleontological evidence.

It seems likely that there are really two sorts of populations contained in the above list, first, relicts of what were once more wide-spread stocks and second, true endemics that have originated and persisted here. Let us look at the evidence for each.

We know that *Alligator* is nothing but an example of a relict distribution of a once wide-spread population since the fossil record indicates an earlier more extensive distribution. Indeed it is still in existence today in southeastern Asia as well as in the southeastern United States.

Another example of a remnant of a once more widely distributed form is the Alligator Snapping Turtle, *Macroclemmys,* which now occurs only on the lower coastal plain from the Mississippi River to the Okefinokee Swamp although it is known from the Miocene and Pliocene of Nebraska.

At the present time the family Sirenidae comprises two genera. *Siren* has two species, *lacertina* of the Southeast and the wide-ranging *intermedia* which extends as far as extreme northeastern Mexico. *Pseudobranchus,* with its several geographic races, is confined to the lower southeastern states, from about Charleston, South Carolina, south and west through peninsular Florida to just beyond the Apalachicola River.

At the time Carr (1940) prepared his list, the Sirenidae were unknown as fossils except for a few scattered Pleistocene records of *lacertina* from Florida. This is no longer so. Today the earliest record of any sirenid is from the Early Cretaceous Trinity sands of Montague County, Texas. From these beds were taken three vertebrae, two of them rather fragmental, which are assigned to an undescribed genus rather than to the modern genus *Siren.* The material is too scanty to yield much information about evolutionary lines, but it does, definitely, indicate the antiquity of the family and assures us that Sirenidae were present in the United States in the Lower Cretaceous. The next sirenid record is from the Upper Cretaceous of Wyoming where we have another undescribed genus. This is a much more "Siren" looking animal, but it too is assigned to a different genus. It does, however, indicate that the family was present in former times in regions where it does not occur today. We find true *Siren* in the Eocene of Wyoming, indicating that the genus *Siren* has existed throughout most of the Cenozoic and that it was earlier distributed in regions where it is not found at the present time.

None of these records, however, contributes to our knowledge of the zoogeography of Florida other than to indicate that the genus *Siren* was in existence well before there was a land mass in Florida to be occupied by it. Our first Floridian record is of *Siren hesterna* from the Lower Miocene of the Raeford Thomas farm in Gilchrist County. This Miocene record, of course, indicates only that there was a land mass with fresh water in Florida during the Lower Miocene and that *Siren* had been able to move in to occupy it. In the Alachua formation of the Pliocene we find the genus *Siren* still present and a recognizable, although as yet somewhat poorly differentiated, *Pseudobranchus,* so that for the first time we have two contemporary genera of Sirenidae at the same locality. Both genera were still present in the Pleistocene of Florida and are here today as well differentiated genera. The paleontological record thus indicates that the genus *Pseudobranchus* came into existence sometime before middle Pliocene times, probably directly from the genus *Siren,* and that the two have continued to live side by side and to differentiate. This is the sort of evidence that herpetologists have been looking for.

None of the herpetologists of my acquaintance has been willing to admit that such genera as *Neoseps, Rhineura, Stilosoma* and *Pseudobranchus* have arisen entirely in post-Pliocene times. Yet, until recently, geologists would not admit continuous land in peninsular Florida from the Pliocene to the present, and there was no paleontological evidence to the contrary. Now, however, this geologic interpretation has been abandoned, for Cooke (1945) has shown persistent, albeit small, islands in his latest map, and Vernon (1951) admits land since the Miocene. In further discussion of this problem, Dr. Vernon wrote me:

> "However, the area of Florida that extends from the Chattahoochee River to slightly east of the Suwannee River is a broad, flat plain, that I interpret as being a Miocene plain surface that is underlain by Middle-Miocene deposits. These deposits, in part, lie directly upon the Suwannee limestone of Oligocene age and no Tampa is present. This delta plain was an area that can be compared to the Mississippi Delta today, and it supported a large and diverse plains dwelling vertebrate animal group. The delta was developed upon a land surface that had existed through the Tampa time, and it was built throughout the Miocene. It has not been subsequently recovered by younger marine deposits."

With this interpretation that a relatively large land mass has been in continuous existence in Florida from the Middle Miocene to the present, and the knowledge that the genus *Pseudobranchus* is not a Post-Pliocene form, but rather arose sometime earlier, probably between the Lower Miocene and the Lower Pliocene, the picture is now entirely changed.

The paleontological data and the geologic interpretations thus would seem to indicate beyond a reasonable doubt that the genus *Siren* has been in Florida since the Lower Miocene, that at least some land mass has been permanent in Florida since those times; that on this land mass the genus *Siren* gave rise to the genus *Pseudobranchus;* and that since it arose *Pseudobranchus* has spread only slightly from its center of origin, up to South Carolina and west to beyond the Apalachicola River.

Although fossil evidence is lacking, I strongly suspect that other southeastern genera, such as *Manculus* and *Neoseps,* have had histories similar to that of *Pseudobranchus.* On the other hand, we know that this is not true for all of the genera now restricted to Florida. For example, *Rhineura* is now found solely in peninsular Florida but obviously it has not been completely evolved here since the Miocene, for the genus is known from the Oligocene of Colorado, South Dakota, Nebraska and Wyoming. It seems evident that it, like *Siren,* had a different distribution in earlier times and made its way to the Miocene land mass of Florida. For some reason it has become extinct elsewhere. In Post-Miocene times it has spread but little from that asylum which it found in Florida. The same is true of *Alligator* and *Macroclemmys.* Although the fossil record is lacking, it may be that other reptilian genera, such as *Liodytes,* have had similar histories.

At the present time there is not sufficient basis for any firm conclusions regarding the derivation of *Amphiuma, Abastor, Deirochelys* and *Seminatrix.* In each case the genus involved may have originated on the Miocene land mass of Florida and have subsequently spread, or may be a group that found asylum here during the Miocene and was not wholly eliminated elsewhere, as was for example *Rhineura.*

It seems pertinent to mention one other fact. These genera, whether they originated in Florida through endemism, or whether they simply found asylum here, all have one thing in common—they are secretive forms, either burrowing in mud, like *Pseudo-*

branchus and *Siren,* or in sand, like *Neoseps* and *Rhineura,* or being secretive aquatic creatures, like *Liodytes* and *Macroclemmys.* What there is about Florida that has permitted the evolution and perpetuation of secretive forms is still a matter of conjecture.

Thus we see that the Miocene land mass in Florida, perhaps originally built up as a deltaic plain but certainly an island for much of its history, has served both as a source of evolution for the formation of new genera and also as an asylum for forms that earlier were more wide-spread but that for some reason or other became extinct over much or all of their former ranges.

The fauna that moved into the Miocene land mass of Florida was quite different from that found here at present. None of the six snake genera known from the Florida Miocene is in existence today. Yet in addition to *Siren* a number of modern genera were present, including *Scaphiopus, Bufo, Hyla, Microhyla, Rana, Pseudemys,* and a newt closely allied to, if not actually a member of, the genus *Diemictylus.* Except for the newt and the *Rana,* these are forms with western affinities. They are, for the most part, rather vagile creatures which had wide ranges then and have wide ranges now. They do not seem to have been affected, in an evolutionary sense, to the extent the secretive forms were by the formation and probably later isolation of the Florida Miocene land mass. They got here, it is true, but they were not eliminated elsewhere and apparently they were not sufficiently isolated for a long enough period of time from the mainland populations to give rise to endemic genera. At least, if such genera did originate we have not yet found any fossil record of them and they certainly have not lived up to the present time. It is tempting to hypothesize an archipelago, isolating the secretive burrowers but not forming a complete barrier to 'island-hopping' frogs.

The fact that *Scaphiopus* has been in Florida since the Miocene and the further fact that it is unquestionably a toad of desert affinities gives us some clue to the persistence of breeding habits. In Florida, *Scaphiopus,* living as it has since the Miocene in a land where there are abundant ponds, lakes and streams, still retains its desert habit of breeding in temporary waters only. Furthermore the tadpoles transform at rates indicative of drying puddles. It would seem, then, that the breeding habits of *Scaphiopus* as exhibited in Florida at the present time have remained unchanged at least since Miocene times although it has been away from desert country where such habits are obligatory for at least that long.

The herpetofauna of the Florida Pliocene was much larger and here we find such modern genera as *Heterodon, Micrurus, Agkistrodon, Crotalus, Ophisaurus* and a *Farancia*-like snake. This Pliocene influx was obviously predominantly western in origin.

In the Pleistocene, many more modern genera made their appearance, including: *Ambystoma, Amphiuma, Plethodon, Acris, Pseudacris, Chelydra, Macroclemmys, Sternotherus, Kinosternon, Trionyx, Gopherus, Anolis, Sceloporus, Cnemidophorus, Storeria, Thamnophis, Diadophis, Rhadinaea* and *Coluber.* Some of these forms, *Kinosternon, Gopherus, Sceloporus, Cnemidophorus, Thamnophis, Diadophis, Rhadinaea* and *Coluber* are western. Any of them may, of course, have reached Florida in the Pliocene, although unrecorded from then as fossils. Many of the Pleistocene genera, such as *Ambystoma, Plethodon, Acris, Pseudacris, Chelydra, Sternotherus, Trionyx* and *Storeria,* were from the eastern United States. This seems to have been the first large influx into Florida from the northeast. By and large the Pleistocene herpetofauna was very similar to that found in Florida today.

Obviously, evolution in Florida did not stop in the Middle Cenozoic. The genus *Sceloporus* has an endemic species in Florida which occupies the habitat known as Rosemary Scrub. In all probability the species *Sceloporus woodi* evolved on Florida Islands, whether Pleistocene or Pliocene, but its differentiation did not take so long as did the evolution of such genera as *Pseudobranchus.* At the present time raciation seems to be occurring in Florida. Many wide-ranging forms have given rise to subspecies on the Peninsula. Some of them may go back to the Pleistocene when much of Florida was undoubtedly insular.

LITERATURE CITED

AUFFENBERG, WALTER

1956. Remarks on some Miocene anurans from Florida, with a description of a new species of *Hyla.* Breviora, no. 52 : 1-11, 3 figs.

1958. A study of the fossil snakes of Florida. In press.

CARR, ARCHIE

1940. A contribution to the herpetology of Florida. Univ. Fla. Publ., Biol. Sci. Ser., vol. 3 (1) : 1-118.

COOKE, C. WYTHE

1945. Geology of Florida. Bull. Florida Geol. Surv., no. 29 : ix + 339, 1 pl., 47 figs.

DUNN, EMMETT REID

1931. The herpetological fauna of the Americas. Copeia, 1931 (3) : 106-119, 6 figs.

GOIN, COLEMAN JETT, and WALTER AUFFENBERG

1955. The fossil salamanders of the family Sirenidae. Bull. Mus. Comp. Zool., vol. 113 (7) : 497-514, 3 figs.

TIHEN, J. A.

1951. Anuran remains from the Miocene of Florida, with the description of a new species of *Bufo*. Copeia, 1951 (3) : 230-235, 2 pls.

VERNON, ROBERT O.

1951. Geology of Citrus and Levy Counties, Florida. Bull. Florida Geol. Surv., no. 33 : xi + 256, frontis., 2 pls., 40 figs.

THE EVOLUTIONARY HISTORY OF THE PICTUS GROUP OF THE CRAYFISH GENUS *PROCAMBARUS* (DECAPODA, ASTACIDAE)

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The genus *Procambarus,* one of the nine genera of the holarctic family Astacidae, is represented in North America by approximately 100 species and subspecies. Sixteen of these occurring in the extreme southeastern part of the United States have been referred to collectively as the *Pictus Group* (Hobbs, 1942 : 129). The range of the group extends from the southeastern part of North Carolina southwestward to the central portion of the Florida peninsula and westward in the Florida panhandle across the Apalachicola River.

Among these sixteen recognizable forms are found some of the most generalized and some of the most highly specialized crayfishes of the North American continent. The ten more generalized species, composing the Pictus Subgroup, are inhabitants of streams in the lower piedmont and coastal plain throughout much of the range of the Group (Map 1). The six more divergent members of the group are equally distributed (Map 2) in the subterranean waters of Florida and in lentic and sluggish lotic surface waters of the coastal plain from North Carolina to Florida.

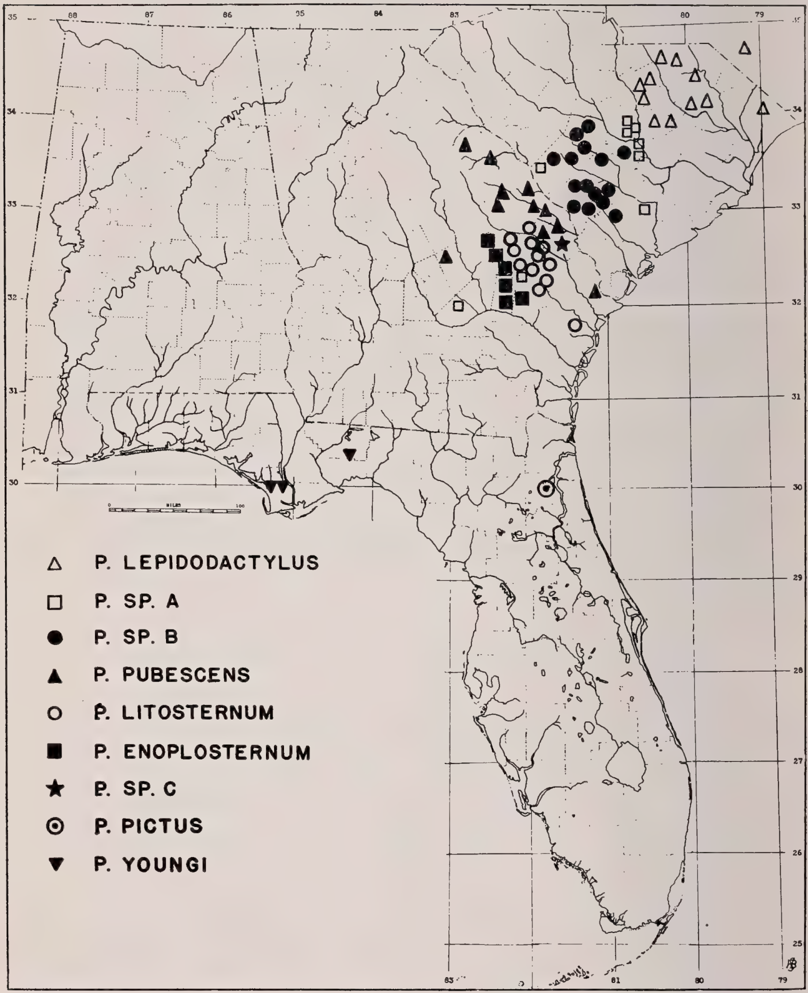
A summary of the inter-relationships and ranges of these sixteen species is presented here, with a discussion of the possible evolutionary history of the group.

Phylogenetic Position of the Pictus Group

It is not within the scope of this review to present an argumentative analysis of the nature of primitive characteristics in the members of the subfamily Cambarinae; however, certain basic assumptions must be stated prior to a discourse on phylogenetic trends that are supposed to have occurred in the ancestral lineage of the species concerned.

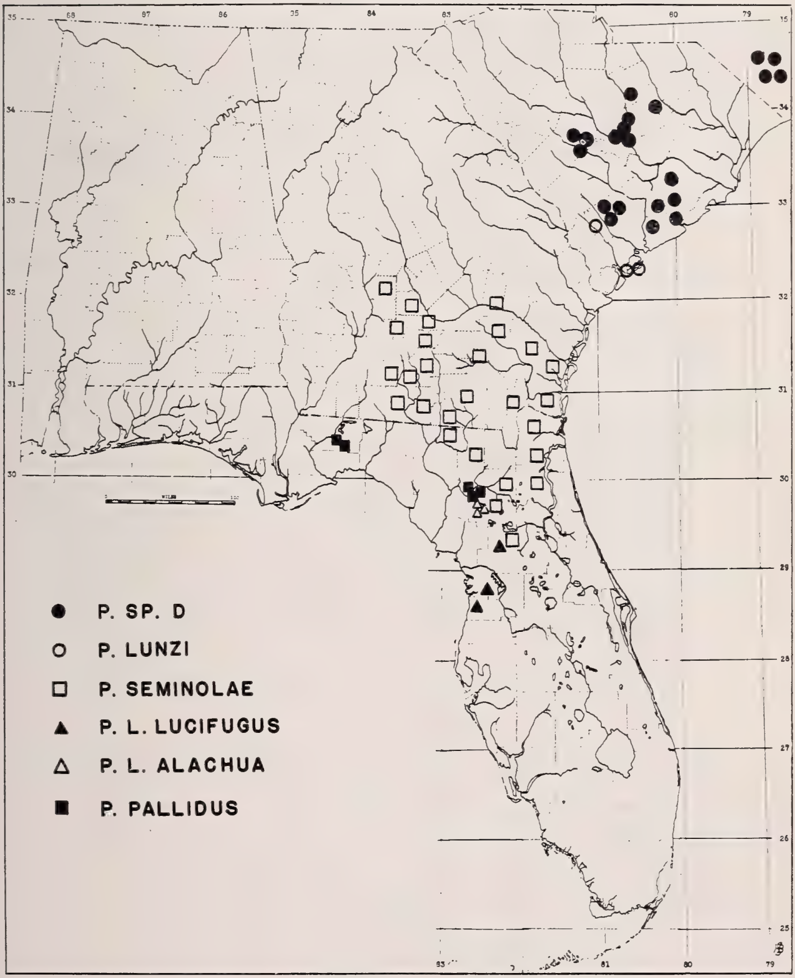
There are a number of reasons why this assemblage is here considered to comprise some of the most primitive members of the subfamily Cambarinae, and from them four are chosen for brief discussion.

A *broad, short areola* (not more than four times as long as broad, and its length not exceeding thirty per cent of the total length of the carapace) in contrast to a narrow, long one is here deemed more generalized. Such an assumption is in accord with the characteristics of the more generalized members of the other groups of the genus, as well as with those of more distant relatives in the family Astacidae.



Map 1. The distribution of the members of the Pictus Subgroup.

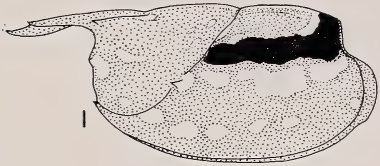
On the assumption that ornamentation, in the way of spines and color patterns, is more readily lost than gained in almost precisely the same arrangement or pattern, it is assumed that a *rostrum with subparallel or convex margins and bearing a pair of marginal spines* (figure 3) is a more generalized type than one in which the margins converge or are lacking spines altogether. It is known, for instance,

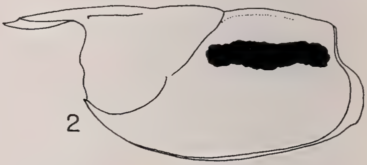


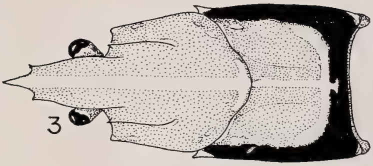
Map 2. The distribution of the members of the Seminolae and Lucifugus subgroups.

that the young of *Cambarus latimanus* in many localities have rostra with subparallel margins bearing lateral spines but that the adults in many areas lack such spines. This has also been observed in one of the undescribed members of the Pictus Group.

The *first pleopod of the first form male terminating in four distinct elements* is considered to be more primitive than one terminating in fewer elements since a repeated loss or reduction of one or more of them seems more probable than an erratic reapparance, in the same position, of such outgrowths.







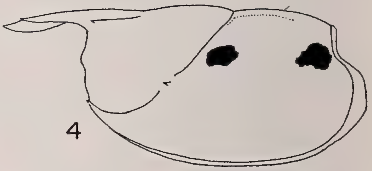


Figure 1. Lateral aspect of the carapace of *P. pictus* showing the sinistral *horn* and sinistral half of the *bar* of the saddle (in black).

Figure 2. Lateral aspect of the carapace of *P.* sp. D showing the reduced saddle with only the *horns* (only the sinistral one evident).

Figure 3. Dorsal aspect of the carapace of *P. pictus* showing the entire *saddle* (in black).

Figure 4. Lateral aspect of the carapace of *P.* sp. C showing only the two lateral *spots,* remnants of the sinistral *horn.*

A *color pattern* (figures 1 and 3) *which includes a U-shaped "saddle" on the thoracic portion of the carapace* is considered to be more generalized than one that has only portions of the saddle. This saddle is not restricted to the more generalized members of the Pictus Group but is also found in other crayfishes. "Spots" or "bars", representing segments of the saddle, are found in forms that are considered to be less primitive.

Other characteristics may be mentioned; however, these will suffice in the present discussion. Inasmuch as all four of these characteristics are found together in certain members of the Pictus

Group, those species are accepted as more closely approximating the ancestral stock of the Group than are those which do not combine them, and it is my opinion that this stock was, in all probability, ancestral to the entire genus *Procambarus*, if not to all the members of the Cambarinae.

Range of the Group

As stated in the introductory paragraphs, the range of the group extends from the southeastern part of North Carolina southwestward to the central portion of the Florida Peninsula and westward in the Florida panhandle across the Apalachicola River. In relation to the genus *Procambarus* as a whole, it occupies what almost amounts to the southeastern periphery of the range. Furthermore, the range is not a continuous one (Maps 1 and 2). Although collections have been made throughout most of the region between the known extremities, there appear to be gaps that are not readily explainable. For instance, there are no truly lotic members of the group in the triangular area between the Altamaha River in Georgia and the St. Johns and St. Marks rivers in Florida. Certainly the rivers and their tributaries in this area are similar to streams from which members of the group have been collected, and the absence of representatives of the Group in these streams is difficult to explain. Another obvious gap in the range, which I have been unable to explain, is the absence of a lentic species in the area between the Altamaha and Savannah rivers. Except for these two "ecological vaccua" in relation to the Pictus Group, the range cannot be said to be discontinuous.

Affinities Within the Group

Within the assemblage of crayfishes assigned to the Group there seem to be three distinct subgroups which are distinguishable both on anatomical and ecological bases. The most easily recognizable are the subterranean members, all of which are albinistic. This, the Lucifugus Subgroup, comprises two species, one of which is represented by two geographic races. The Pictus Subgroup consists of 10 species which seem to be restricted to permanent lotic situations. The Seminolae Subgroup comprises three species that frequent lotic and lentic, temporary and permanent bodies of water.

The Pictus Subgroup.—Of the ten species that belong to this subgroup all except three have been described, and these are here referred to as *Procambarus* sp. A, *Procambarus* sp. B, and *Procambarus* sp. C. These crayfishes all have short, broad areolae, and the males possess a first pleopod terminating in three or four distinct terminal elements; in most of them the margins of the rostrum are convex, subparallel, or slightly convergent, and all bear a pair of marginal spines; the color pattern is quite variable, but all have the entire "saddle" or portions of it.

Geographically the range of this subgroup is almost identical with that of the group, extending from tributaries of the Pee Dee River in southeastern North Carolina southward to Florida. There are no representatives of the subgroup in the triangular area between the Altamaha River in Georgia and the St. Johns and St. Marks rivers in Florida.

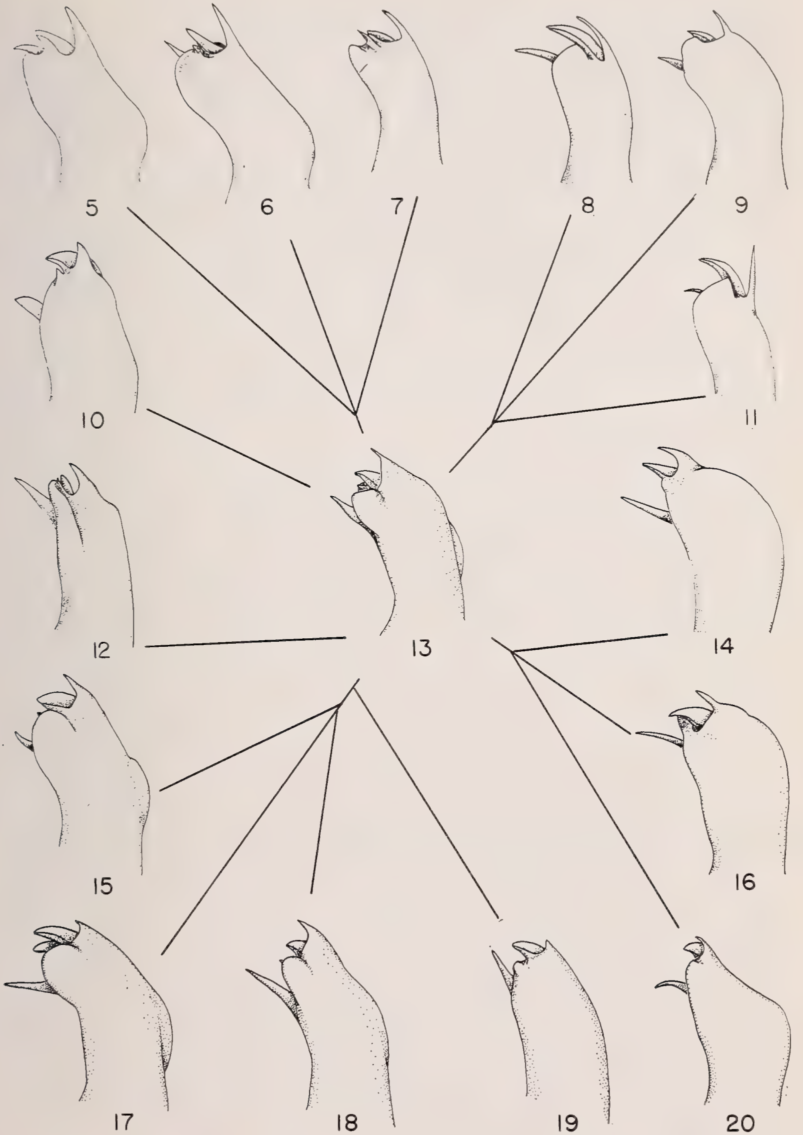
The ecological requirements of all of them seem to be satisfied in streams (mostly sand-bottomed) of the lower piedmont and coastal plain. The size of the stream, as well as the condition of the water, whether clear, silt-laden, or coffee-colored, appear to have no effect on the subgroup as a whole. Whether or not certain species may be limited by these factors remains to be demonstrated. There seems to be little doubt that a lotic habitat is necessary. These species occur abundantly in beds of *Vallisneria* and other aquatic plants. They also are found in litter and roots along the undercut banks of streams.

Procambarus lepidodactylus Hobbs (1947b : 25) has been collected from stream tributaries of the Pee Dee, Black, and Wateree rivers in the lower piedmont and coastal plain of South Carolina, and in extreme southeastern North Carolina.

Procambarus sp. A occurs in stream tributaries of the Wateree, Congaree, Edisto, and Savannah rivers in South Carolina, and from two apparently isolated localities in the Ogeechee and Ocmulgee rivers in Georgia.

Procambarus sp. B is found in stream tributaries of the Edisto, Salkehatchie, and Savannah rivers in South Carolina.

Procambarus pubescens (Faxon) (Faxon 1884 : 109) is known from stream tributaries of the Savannah, Ogeechee, and a single locality in the Altamaha river systems in Georgia.



Figures 5-20. Lateral views of terminal portions of first pleopods of first form males. 5. *P.* sp. B; 6. *P. pubescens;* 7. *P. youngi;* 8. *P.* sp. D; 9. *P. lunzi;* 10. *P. lepidodactylus;* 11. *P. seminolae;* 12. *P. litosternum;* 13. *P. pictus;* 14. *P. lucifugus lucifugus;* 15. *P. enoplosternum;* 16. *P. lucifugus alachua;* 17. *P.* sp. B; 18. *P.* sp. A; 19. *P. angustatus;* 20. *P. pallidus.*

Procambarus sp. C is known from a single stream tributary of the Ogeechee River in Screven County, Georgia.

Procambarus enoplosternum Hobbs (1947a : 5) frequents the stream tributaries of the Ohoopee River (tributary of the Altamaha River) in Georgia.

Procambarus litosternum Hobbs (1947a : 9) is known from the Canoochee, Ogeechee, and Newport rivers in Georgia.

Procambarus pictus (Hobbs) (Hobbs 1940a : 419) has been collected from a number of tributaries of Black Creek (tributary of the St. Johns River) in Clay County, Florida.

Procambarus youngi Hobbs (1942 : 131) is known from the St. Marks River, Leon County, Florida, and from a tributary of the Chipola River and from Wetappo Creek—the latter two in Gulf County, Florida.

Procambarus angustatus (LeConte) (LeConte 1856 : 401) is known only from the single type specimen in the Philadelphia Academy of Natural Sciences. The type locality cited by LeConte is exceedingly vague: "*Habitat in Georgia inferiore, in aquae purae rivalos qui inter colloculos arenosus* [sand-hills] *currunt.*" Efforts to find additional specimens of this distinct crayfish have thus far failed, and consequently no further reference is made to it in this discussion.

The characteristics of these species are summarized in Table 1 and figures 5, 6, 7, 10, 12, 13, 15, 17, 18, 19.

The Seminolae Subgroup.—Three species of the Pictus Group are united here because of their similar morphology and ecological distribution. One of the three has not been described and is herein designated as *Procambarus* sp. D. These crayfishes in general have narrower areolae than do most of the members of the Pictus Subgroup; the first pleopod terminates in only three distinct parts; the margins of the rostrum are convergent, and occasional specimens are found in which the marginal spines are reduced or absent; the color pattern is somewhat variable, but the "lateral horns of the saddle" are present or are represented by two pairs of dots as in figures 2 and 4.

The range of the subgroup extends from the lake region in southeastern North Carolina throughout the coastal plain (except between the Savannah and Altamaha rivers in Georgia), and on some of the coastal islands of South Carolina to Marion County, Florida.

Table 1. Summary of the characteristics of the members of the Pictus Group.

	Pictus Subgroup (Lotic Habitats)										Seminolae Subgroups (Lentic Habitats)			Lucifugus Subgroup (Subterranean Habitats)		
	P. angustatus	P. enoplosternum	P. lepidodactylus	P. litosternum	P. pictus	P. pubescens	P. youngi	P. sp. A	P. sp. B	P. sp. C	P. lunzi	P. seminolae	P. sp. D	P. l. lucifugus	P. l. alachua	P. pallidus
Areola lgth. / Carapace lgth. x 100	28.6	26.0—29.0	28.0—29.0	27.0—28.5	25.5—27.5	26.0—28.0	25.0—30.0	26.0—28.0	25.5—30.0	28.0—30.5	32.0—34.0	28.0—30.0	34.0—35.5	38.0—40.0	37.0—39.0	38.0—43.0
Areola lgth. / Areola width.	4.2	4.5—5.0	3.3—5.2	3.0—4.5	2.5—3.1	2.5—3.5	3.0—3.5	2.8—4.0	2.5—3.5	4.0—5.0	5.5—6.2	4.7—5.2	4.8—9.0	27.0—30.0	10.4—16.0	25.0—36.0
Rostrum	P	T	T	T	C-T	T	P	P	C-T	T	T	T	T	C	P-T	T
Color Pattern (Saddle)	?	s,B	B	s,B	S	wS or s,B	S	s,B	wS or s,B	H	s	s	H	A	A	A

A—albinistic; B—bars of saddle; C—convex margins; H—horns of saddle; P—parallel margins; s—two pairs of spots representing portions of horns; S—complete saddle; T—margins tapering toward apex; wS—saddle present but not sharply defined.

Representatives have not been reported from the panhandle of Florida.

The members of this subgroup frequent streams (usually the very sluggish areas), ponds, lakes, swamps, and roadside ditches. Too, they are found both in permanent and temporary bodies of water provided the watertable recedes not more than a few feet below the surface. They frequently dig simple, straight or gently slanting burrows, but seldom are the chimneys well-formed. Thus, these three species have a broader ecological tolerance than do the members of either of the other two subgroups. In spite of this, there are reasons to believe, as will be pointed out below, that they have been derived from a stock that resembled more closely the members of the Pictus Subgroup.

Procambarus sp. D ranges from Columbus and Bladen counties, North Carolina, in the lowermost portions of the piedmont and in the coastal plain to the Santee River system in South Carolina.

Procambarus lunzi (Hobbs) (Hobbs 1940b : 1) has been found in Hampton County, South Carolina and from several of the coastal islands in Beaufort County.

Procambarus seminolae Hobbs (1942 : 142) occupies a broad range from the Altamaha River, Georgia, southward to Marion County, Florida.

The characteristics of these species are summarized in Table 1 and figures 8, 9, 11.

The Lucifugus Subgroup.—Three of the six albinistic species reported from Florida belong to the Lucifugus Subgroup. All three have long, very narrow areolae; the first pleopod terminates in three or four well-defined elements; the margins of the rostrum are either convex, subparallel, or convergent and may or may not bear well-defined marginal spines; color is absent except occasionally for a straw brown shading on the abdominal terga of *P. lucifugus alachua.* It is only in this latter subspecies that any trace of pigment remains in the eyes.

The range of the subgroup is confined to Florida where it extends from Hernando County northward to Columbia County, and two localities are known in Leon County.

All three of these are confined to the subterranean waters and are found only in caves, sinkholes that reach the water table, and in an occasional well.

Procambarus lucifugus lucifugus (Hobbs) (Hobbs 1940a : 398) is known from only two caves, one each in Hernando and Citrus counties, Florida.

Procambarus lucifugus alachua (Hobbs) (Hobbs 1940a : 402) is known from a number of caves and sinkholes in the western part of Alachua County, Florida. Specimens that are somewhat intermediate between these two subspecies have been collected in Marion County.

Procambarus pallidus (Hobbs) (Hobbs 1940a : 394) has been taken from caves and sinkholes in the northwestern part of Alachua County and from the southern part of Columbia County, Florida. Juvenile specimens, from two sinkholes in Leon County are tentatively assigned to this species.[1]

PHYLOGENETIC TRENDS

The entire concept of phylogeny rests on the assumption that from ancestral stocks, there have arisen, in time, the organisms that populate the Earth. Therefore the synthesis, or reconstruction, of the racial history of a group must entail at least a mental picture, regardless of how vague, of the characteristics of a member of the ancestral stock. Oftimes the fossil record will aid in bringing some of the characteristics into sharp focus and thus enable the student to depict those characteristics with less temerity. Most often, even with the aid of fossils, there are certain characteristics of this organism the nature of which must be postulated, so that a "hypothetical ancestor" is not a foreign concept to any student of evolution. For many groups of organisms the fossil record has been erased, or is so fragmentary as to be practically useless. Such is the case with the crayfishes of the Pictus Group. At the present no fossils of crayfishes related to the members of this Group are available. In the absence of the fossil record one must attempt to reconstruct from the maze of diversity existing in modern forms, an organism consisting of a combination of characteristics that appears to serve as a focal point from which the many lines of variation have diverged. Having no concrete evidence for the actual existence of any part of such an organism, the student is more reticent in presenting a concise description of this ancestor than if there were a few fossils to give him some assurance that he was partially correct in his assumptions. Nevertheless, he must have reached certain conclusions concerning the ancestor even if all that is in clear focus in his mind are a few bristles!

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[1] I wish to thank Mr. H. R. H. Heinemann of Florida State University for permitting me to include the records from Leon County.

For the purposes of the present discussion only four characteristics of the hypothetical ancestor of the Pictus Group are presented in "sharp focus": a broad, short areola (figure 3), a color pattern emphasizing a saddle (figure 3), and a gonopod (first pleopod) terminating in four distinct terminal elements (figure 13).

The Areola.—Although there are no experimental data available to support field observations that, in general, crayfishes with broad areolae are confined to lotic habitats, there seems to be little reason to doubt that as the length of the areola increases and the breadth decreases, there is a concomitant enlargement of the gill chamber. Regardless of the specific physiological effects, crayfishes with narrow, long areolae frequent both lentic and lotic habitats.

The members of the Pictus Subgroup have all retained a broad, short areola—ranging from 2.8 to 5.0 times as long as broad, and from 25.7 to about 30 per cent of the entire length of the carapace (Table 1). The members of the Seminolae Subgroup have, in general, somewhat narrower and longer areolae—ranging from 4.7 to 9.0 times as long as broad, and from 28.0 to 35.5 per cent of the entire length of the carapace. The narrowest and longest areolae encountered in the Pictus Group are in the members of the Lucifugus Subgroup where it is from 10.4 to 36.0 times as long as broad, and from 37.0 to 43.0 per cent of the entire length of the carapace. Thus, if the postulate that the generalized areola is a broad short one is tentatively accepted, it becomes obvious that the stream dwellers have retained the generalized type, the ubiquitous members a somewhat intermediate type areola, and that the extreme types are to be found in the members frequenting subterranean habitats.

The Rostrum.—Although there is a considerable degree of variation in the rostra of most of the species, and apparently some of the variation may be correlated with the type of habitat in which the crayfishes are found, there are certain types that may be generally associated with each species. It seems probable that all of the rostra have been derived from one in which the basal margins are parallel, become slightly convex, and again parallel to the base of the acumen where there is borne a pair of well developed lateral spines. This type of rostrum is found frequently in *Procambarus pictus* and *Procambarus* sp. A, and occasionally in some of the other species of the Pictus Subgroup. Variations deviating from this type include rostra like those always found in *P. youngi* in which the margins are almost parallel from the base to the marginal spines, and in this species the acumen is as long as, or longer than, the remaining part of the rostrum. A third type of rostrum, in which the margins are parallel at the base but converge cephalically to the marginal spines, is found most frequently; in general, this convergence is most extreme in the members of the Seminolae Subgroup where in some animals the marginal spines are entirely lacking, and there is scarcely to be found an emargination delimiting the base of the acumen. It is of interest that in the Lucifugus Subgroup, the rostrum of *P. lucifugus lucifugus* is remarkably like that of the generalized type in that the margins are markedly convex; they are less so in *P. lucifugus alachua,* and in *P. pallidus* they are almost always markedly convergent.

Among the members of the three subgroups it may be seen that the more generalized rostrum is found in the Pictus and Lucifugus subgroups and that the extreme type is more typical of the members of the Seminolae subgroup; however, it should be emphasized that occasional specimens of *P. seminolae* and *P.* sp. D have rostra that more nearly approach the generalized type than do some specimens of *P. enoplosternum, P. litosternum,* and *P.* sp. C.

The First Pleopod of the Male.—For many years it has been recognized that the complex structure of the first pleopod of the first form male affords the best single characteristic by which species of the genus *Procambarus* may be distinguished and at the same time point toward relationships between them. In the Pictus Group it seems probable that again we are forced to rely heavily on resemblances and differences observed in this appendage for the more detailed postulates concerning the evolution of the several species. Whereas it seems highly probable that the invasions of various types of habitats have been possible only when certain modifications in the areolae and rostra of the crayfishes were accomplished, there is no evidence to indicate that a reorganization of the pleopod was involved. Certainly there are no generalizations that have been recognized that tend to correlate a certain type of pleopod with a particular type of habitat. Thus, in attempting to reconstruct adaptive radiation in this group, if there is no evidence among crayfishes in general that certain pleopod types may be correlated with certain environments, it seems probable that its use as a yardstick to measure relationships would be more reliable than other characteristics that reflect in part, at least, the habitat in which the animal lives.

An analysis of the pleopods of all the species of the Pictus Group has resulted in the postulate that the most generalized pleopod, and consequently that which probably should be considered to approach that of the hypothetical ancestor of the group, is that of *Procambarus pictus* and *Procambarus* sp. A. Rather than becoming involved in a long, detailed, verbal account of the relationships indicated by a comparison of the pleopods of the species concerned, figures 5 through 20 have been included. Lines have been drawn between them to indicate postulated affinities of all the species of the group. For orientation in attempting to recognize homologous terminal elements, it is suggested that the *central projection*, consisting in each instance of two closely applied parts, be used as a focal point.

The major trends in the evolution of the first pleopod appear to have been (1) in a reduction and loss of the caudal element. In all of the species of the Pictus Subgroup, except *P. youngi* and *P.* sp. B, the caudal process is present in the form of a small corneous tooth. It is absent in the two species just mentioned and in all of the species assigned to the Seminolae and Lucifugus subgroups. (2) Another trend has been in the suppression of the shoulder on the cephalic margin of the appendage. While it was impossible to illustrate adequately this in figures 5 through 20, the shoulder is best developed in *P. pictus*, somewhat less well developed in *P. enoplosternum* and *P.* sp. A; it is folded mesially, represented by vestiges, or is absent in the others. (3) The *cephalic process* which somewhat hoods the central projection in the more generalized forms appears to have become more spine-like in the members of the Seminolae Subgroup and in *P. youngi, P. pubescens,* and *P.* sp. B, and in *P. lepidodactylus* it has assumed a position lateral to the central projection.

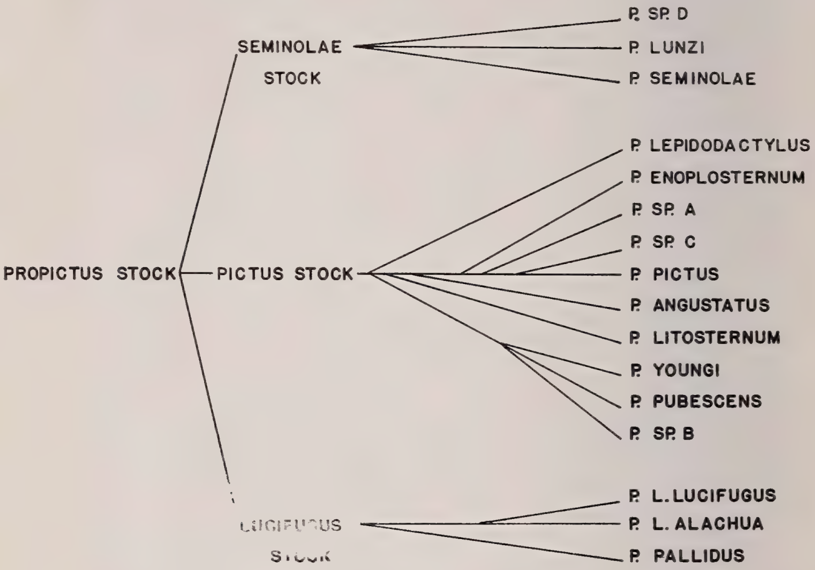
Color Pattern.—The color pattern that is found in *Procambarus pictus* appears to be as generalized as that of any member of the group, and is illustrated in figures 1 and 3. A detailed description of this is beyond the scope of the present discussion, and only the "saddle" marking is given attention here. For simplicity in discussion it is considered to consist of a posterior *bar* which extends across the caudal margin of the carapace and the two forward-projecting lateral *horns*. In *P. pictus* this saddle is complete: the bar has a slight median emargination, and its ventrolateral terminii are continuous with the paired horns that extend cephalically to the cervical groove. While there is slight variation in *P. pictus* in the depth of the median emargination on the bar so that it is occasionally bisected, the general pattern is that represented in the figures indicated above. This pattern is most closely approached by *P. youngi* and *P.* sp. A; however, the lateral horns do not extend forward to the cervical groove, and the bar is usually broken on the median line. The bar and the two lateral pairs of dark spots representing the anterior and posterior portions of the horn are present in *P. enoplosternum, P.* sp. C, *P. pubescens,* and *P. hirsutus.* In some specimens of all of these the two dark spots may be connected by a band that is somewhat diffuse and paler in color. In *P. lepidodactylus* the lateral spots are not always present, but the broken bar is always evident. In *P. lunzi* and *P.* sp. D the bar is lacking, but the paired horns are complete (figure 2). In *P. seminolae* the bar is lacking and the horns are represented by two pairs of lateral spots (figure 4) corresponding to the anterior and posterior portions of each horn.

It seems apparent that the trend in variation insofar as the pattern of the saddle is concerned is toward its obliteration; however, only in the albinistic forms has it been completely eliminated. Extreme reduction is seen in *P. seminolae* which has only the two pairs of lateral spots (portions of the horns) and in *P. lepidodactylus* which has two segments of the bar. That these so-call remnants are actually homologous to portions of the saddle can scarcely be denied when specimens of all of the species are compared and almost a complete series of intermediate patterns are noted.

History of the Pictus Group

On the basis of these data, and others that are not presented here, the following diagram has been executed to depict the interrelationships of the members of the Pictus Group.

Although it is highly probable that much of the evolutionary history of the Pictus Group was accomplished during the Pleistocene Period, the invasion of the freshwaters of the area that is now within the boundaries of the Piedmont Province by freshwater crayfishes must have occurred during the late Cretaceous or perhaps during the Tertiary. As has been stated above, the lack of fossils prohibits any accurate temporal assignments in the evolutionary history of the group.



It is postulated that the Propictus Stock had gained a foothold in at least some of the streams of the southeast not later than the Pliocene—probably much earlier—and that their migrations from one river system to another were largely dependent upon stream piracy or short migrations across very narrow land barriers between the dove-tailing headwaters of adjacent drainage systems. (This assumption is made because none of the modern species thought to be similar to the ancestral stock has been found on land or in ponds, lakes, or any other type of lentic habitat.) In this manner the stock invaded most of the major systems in the area between the Pee Dee River in South Carolina and the Altamaha River in Georgia, and during the middle Pliocene when "the Gulf of Mexico extended farther to the north than now, and Florida was a short, stubby peninsula that ended at about the level of Tampa . . . " (Hubbell, 1954 : 46) the stock gained an entrance into the peninsula. Almost certainly by this time the porous Eocene limestone underlying the eastern portion of the peninsula had begun to be honeycombed and there was developing a system of subterranean pools and streams. There is no reason to doubt that some of the surface waters were being deflected from their coastal routes into these subterranean channels, just as is the case at the present time. Certainly such a setting was at least conducive to the invasion of these hypogean waters by members of the stream-dwelling Propictus Stock, and it is postulated that in taking advantage of this opportunity this Stock successfully invaded these waters—perhaps in two areas. In the southern area either two already differentiated stocks independently entered the underground waters, which seems most probable, or there was a subsequent marked dicotomous divergence in members of a single stock, resulting subsequently in the evolution of the sympatric *Troglocambarus maclanei* and *Procambarus lucifugus,* the latter consisting of two geographic races. The second (or third) invasion of the subterranean waters must have occurred farther to the north, this one representing the ancestral stock of *P. pallidus.* The presence of these troglodyte species in the subterranean waters of Florida almost demands an assumed insular land mass throughout the Pleistocene. Hubbell's (loc. cit., p. 48) statements regarding insular Florida are particularly apropos. "Not so long ago the geologists would have none of this [land in central Florida since the Pliocene] at least for the highest Pleistocene level of the sea, but in his latest maps Cooke has left a tiny island exposed just about where it is needed. If it were only a little larger!" In this I heartily concur!

The question arises as to what became of the original surface stock from which the cavernicoles took their origin. Only a small fragment of it is to be found in Florida at the present time—the relict, *P. pictus.* This species, presumably the one most closely approximating the ancestral stock of the group, has been found in only one stream tributary of the St. Johns River in northeastern Florida. Geographically disjunct in relation to its epigean relatives, its presence here can be explained only by the assumption that it is a relict form left on an insular landmass that persisted throughout the submergences of the landmass to the north during the Pleistocene. In support of this hypothesis, it is remarkable that in northeastern Florida Cooke left a sizable island in precisely the right place for the ancestral *P. pictus* to have persisted, and the creek in which it now occurs lies largely within an area of the

Duplin marle, an exposed Miocene formation, apparently occupying the cite of Cooke's island!

Perhaps to be correlated with the developing coastal plain during the Pleistocene is speciation in the Seminolae Stock. Almost certainly there was an offshoot of the Propictus Stock—a segment that ventured into lentic habitats. There is considerable evidence that this was one of the most important events in the evolution of the crayfishes of this genus, for it seems highly possible that the Blandingii Group, one of the largest of the genus, had its origin in this Seminolae Stock. Disregarding the importance of this stock except as it pertains to the Pictus Group, it is postulated that it had its origin in the area between the Santee and Altamaha rivers late in the Pliocene and that with the emergence of the low-lying coastal plain from the ocean during the Pleistocene, the developing ponds and swamps were rapidly invaded by these animals. Not only could they tolerate lentic habitats but also were able to occupy land on which the water table was attainable through their burrowing prowess. The three extant species of this group, assumed to have originated from the Seminolae Stock, present a tantalizing problem in attempting to decipher which most closely approximates the ancestral stock. In rostral characteristics *P. seminolae* and *P.* sp. D. share the honor; the areola of *seminolae* is the broadest and shortest; in color pattern *lunzi* and sp. D are more generalized; and the first pleopod of *lunzi* seems to be more primitive. Thus, until more data are available on these species, or additional related living or fossil forms are discovered, no detailed hypothesis concerning their inter-relationships can creditably be proposed. Of interest in relation to the distribution of the members of this subgroup is the apparent small range of *P. lunzi* and the absence of a representative of the subgroup in the area between the Savannah and Altamaha rivers. One is tempted to explain these two observations by calling on competition with one or more other species—in these situations the eastern red swamp crayfish, *P. troglodytes,* the range of which extends from the Altamaha River northward in the coastal plain to the Pee Dee River system.

Within the Pictus Subgroup, each species is largely confined to a single or adjacent river systems, and except for the streams in the area between the Altamaha, St. Johns, and St. Marks rivers, most of the lotic habitats from the Pee Dee River to the Chipola River in Florida are inhabited by one or more species of the subgroup. As stated above, the single species which is thought to approximate most closely the ancestral stock is the geographically disjunct *P. pictus,* and a possible explanation of its presence in the St. Johns drainage is presented. The only other geographically disjunct species of the subgroup is *P. youngi* which is known from only three localities in the panhandle of Florida.

If it may be assumed that during the Pliocene the Propictus Stock had gained entrance to the major drainage systems from the Pee Dee River southward to Florida, then few postulates are necessary to synthesize a plausible explanation of the evolution of the stream-dwelling descendants of the stock. (1) In the Pee Dee system a marked divergence from the ancestral pattern was soon developed; this is seen in a number of characteristics, among the most obvious of which was the lateral shifting of the cephalic process of the first pleopod of the male (c.f. figures 10 and 13), and from this stock arose *P. lepidodactylus* which probably much later made its way southward into eastern tributaries of the Wateree (Santee system) River. (2) Another marked alteration arose in the stock, here termed the Pubescens Stock, that found its way into the Edisto, Salkehatchie, and Savannah river systems. One of the most conspicuous changes in this group was the loss of the caudal element of the first pleopod of the male (c.f. figures 8, 9, 11 and 13). It is believed that this occurred during the Pliocene and that descendants of this stock reached a tributary of the Apalachicola River, presumably a tributary of the Flint River. With the inundation of much of the coastal plain during Brandywine (early Pleistocene) times, the now three (or more) stream-dwelling derivatives of the old Propictus Stock suffered a severe setback, for except for the insular forms that were able to survive in the area of the Florida peninsula, all of those crayfishes living below the present 270 foot contour perished. With the subsequent retreat of the seas from the coastal plain during the Pleistocene and the accompanying extensions of old drainage systems, the three stocks reinvaded the once inundated area. Never again were any of them to cross southern Georgia, but the Pubescens Stock that had reached the Apalachicola system moved southward and invaded the three streams in the Florida panhandle in which *P. youngi* is now known to occur. Why its distribution is so limited is not known but suitable habitats are not numerous and it is found in an area in which there are a number of apparently very successful species. It is not inconceivable that this species is making its "last stand".

The remaining portion of the Pubescens Stock from which *P. youngi* took its origin was apparently separated into two parts, the more northern of which, occupying the Edisto drainage, gave rise to *P.* sp. B, and subsequently migrated into the younger Salkehatchie River, and eventually into a few eastern tributaries of the Savannah River. The other portion, occupying originally the Savannah drainage, gave rise to *P. pubescens* that invaded the Ogeechee and tributaries of the Altamaha rivers.

In the more conservative Pictus Stock, the ancestors of *P. litosternum,* apparently early isolated in the Ogeechee River, had undergone such divergence that when other representatives of the stock later reached the system there was no opportunity for hybridization. It is thought that *P. litosternum* invaded the Newport system from the Ogeechee. A second invasion of the Ogeechee system by the conservative Pictus Stock and its subsequent divergence resulted in the origin of *P.* sp. C. In the Ohoopee River another segment of this conservative stock developed a tendency toward giantism which perhaps aided in the isolation of *P. enoplosternum.*

Elsewhere the Pictus Stock remained little changed and resulted in the widespread *P.* sp. A which at the present time is known from the Wateree, Congaree, Edisto, and Savannah rivers, and from isolated localities in the Ogeechee and Ocmulgee rivers. It is of interest that this species so closely approaches the facies of *Procambarus pictus,* the species that has repeatedly been cited as that which probably most closely resembles the ancestral stock of the entire group.

Literature Cited

COOKE, C. WYTHE

1945. Geology of Florida. Florida Geol. Surv., Geol. Bull., 29 : 1-399, 47 text figs, 1 map in folder.

FAXON, WALTER

1884. Descriptions of New Species of Cambarus; to Which is Added a Synonymical List of the Known Species of Cambarus and Astacus. Proc. Amer. Acad. Arts and Sci., 20 : 107-158.

HOBBS, HORTON H., JR.

1940a. Seven New Crayfishes of the Genus Cambarus from Florida, with Notes on Other Species. Proc. U. S. Nat. Mus., 89 (3097) : 387-423, figs. 14-22.

1940b. A New Crayfish from South Carolina. Charleston Mus. Leaf., 14 : 1-7, 1 pl.

1942. The Crayfishes of Florida. Univ. of Florida Pub., Biol. Sci. Series, 3 (2) : 1-179, 3 text figs., 11 maps, 24 pls.

1947a. Two New Crayfishes of the Genus Procambarus from Georgia, with Notes on *Procambarus pubescens* (Faxon). Quart. Jour. Fla. Acad. Sci., 9 (1) : 1-18, 2 pls.

1947b. A Key to the Crayfishes of the Pictus Subgroup of the Genus Procambarus, with the Description of a New Species from South Carolina. Florida Entomologist, 30 (3) : 25-31, 1 pl.

HUBBELL, T. H. [in OLSON, A. L., T. H. HUBBELL, and H. F. HOWDEN]

1954. The Burrowing Beetles of the Genus Mycotrupes. Part II. Relationships and Distribution of Mycotrupes. Misc. Pub., Mus. Zool., Univ. Mich., No. 48 : 39-51, 3 text figs.

LeCONTE, JOHN

1856. Descriptions of New Species of Astacus from Georgia. Proc. Acad Nat. Sci., 7 : 400-402.

IN DEFENSE OF THE CONCEPTS OF MAJOR AND MINOR HABITATS IN APPROACHING BIOLOGICAL PROBLEMS[1]

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One of J. Speed Rogers' principal concerns in his studies of the craneflies was the correlation of the distribution and abundance of the adults and larvae of the species with various natural situations. I, among others, began my investigations of aquatic insects along these same lines; and the concepts of major and minor habitats, as developed by Rogers (1933, 1942, and elsewhere) have continued to prove helpful and productive. I do not, of course, presume to claim priority for Rogers in regard to these terms, but certainly he gave them a peculiarly Rogersian turn; and the farther I have progressed in my own investigations, the more central some of Rogers' ideas have become in my thinking concerning the biology of insects. Since some ecologists have criticized the habitat-approach or labelled it unproductive while others have developed similar or quite unrelated concepts in connection with their studies, the appearance of a Rogers' memorial volume seems an appropriate place to reconsider the ideas of major and minor habitat.

The concepts of major and minor habitats are, in my thinking, focal points for organizing data. Before turning to more theoretical considerations, I want to outline briefly some of the facts and certain logical deductions from them concerning the relationship of distribution and abundance in a specific insect in order to give the reader some idea of the type of data on which I plan to base further discussion. For this purpose I have selected *Tropisternus mexicanus*, a medium-sized hydrophilid water beetle, which is currently the subject of intensive investigation.

The problems concerning the distribution of *T. mexicanus* are both taxonomic-genetic and ecological, but the two approaches cannot be clearly separated. For example, the range of the species as a whole extends from Central America to Cuba, north to Indiana and New York. Within this area, however, five distinct subspecies are recognizable on the basis of color pattern each associated with a distinct set of climatic conditions, soils, and vegetation. There is evidence from experiments, however, that the differences in color pattern are genetically controlled and not simply due to environmental influences.

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[1] Contribution No. 624 from the Zoological Laboratories of Indiana University.

In a general way, the coloration conforms to the Allen-Gloger rule. That is, dark forms are associated with humid climates while light forms are found in arid-hot regions. Other elements of the pattern, and other characters do not conform so that a simple ecological correlation seems to be excluded. Ecological factors, however, seem to influence gene flow from one population to another, and conversely the genetic composition of the populations in different parts of the range undoubtedly influences physiological tolerances.

In the United States three subspecies of *mexicanus* have been recognized: (1) Typical *mexicanus* ranges in the United States from the Mexican boundary to Missouri in a narrow strip west of the Mississippi River. In Oklahoma, Kansas, and Missouri the typical form intergrades (on the basis of color pattern) with (2) *striolatus*, which ranges over the states east of the Mississippi south to southern Georgia and western Florida. In the latter area *striolatus* intergrades with (3) *viridis* which is confined to Florida and extreme southeastern Georgia.

This is admittedly an oversimplified model of the population structure within the U. S. segment of the species. The distribution in the areas outlined is obviously not continuous, and there are indications in places of local populations isolated from the main areas of occupation. But nowhere is the distribution random; both frequency of occurrence and abundance center around certain types of aquatic environments. It is only during flights of the adults under relatively windless conditions that we might imagine a random distribution with the numbers of individuals decreasing logarithmically from the larval breeding places.

In defining the types of situations in which the forms of *T. mexicanus* occurs it is necessary to keep in mind several important facts about the biology of the species. The larvae are aquatic predators and scavengers feeding on mosquito larvae and other aquatic insects either alive or dead. The adults, however, are algophages and scavengers which only rarely take live food.

Further, the dispersal of the species is accomplished by flights of the adults which are apparently conditioned by temperature and humidity, but seem also to be influenced to some extent by the drying up of the situation in which they find themselves. The western limit in the U. S. may be fixed by the degree of humidity needed to induce the adults to disperse, and this same effect may account for the failure of the species to follow up the permanent streams into drier regions. The inward curve of *mexicanus* in Missouri may reflect the interaction of humidity and lower temperatures, while the greater extent of habitat occupancy in Florida may represent the other extreme.

Therefore, the habitat selection by the beetles or the beetle selection by the habitat is primarily conditioned by such variables as the presence of suitable larval food, suitable adult food, and suitable recurrent atmospheric conditions to allow the dispersal of the adults. Many other conditions also affect the organisms, of course, such as the presence of predators in relation to shelter, suitability of the surrounding soil for pupation, vegetation for attachment by the larvae and depositing of eggs in relation to currents, temperature extremes, and so on. The conditions of the soil during pupation may be the critical factor in regard to final pigmentation of the adults.

The distribution of the subspecies can be further correlated to some extent with other differences in habitat. The typical form is found most frequently and abundantly along the margins of streams, in backwaters, in pools, in drying stream beds, and in small pools or ponds near streams. The subspecies *striolatus* occupies very similar situations within its range, but is found most frequently in the backwaters of large streams and less frequently in temporary pools. In Florida and southeastern Georgia, as one might expect, *viridis* occurs much more frequently in permanent lenitic situations. It has not, however, forsaken the stream environment as completely as I once thought, and the frequency of the form if not its abundance seems to be greatest where the water is gently flowing.

I believe that the correlation of observations on habitats is beginning to produce concepts which are important in considering not only the ecology but the taxonomic-genetic relationships in this species. The model of the population structure of *T. mexicanus* must take into account the nature and distribution of habitats as well as the more general environmental influences. I think it can best be visualized now in terms of many small breeding areas in which local conditions are influenced by the broad environmental aspects. The connections between these situations are in time not space.

There are still many things to investigate in regard to this problem, but it looks as if we can now begin intensive investigations of the individual factors in the laboratory. How did we reach this point? Certainly not by sitting down and considering the individual factors abstractly, nor even by examining them experimentally in the laboratory. There are too many variables to allow anyone to select the critical points *a priori.* The day may come when biologists using suitable calculating machines and punch cards can attack any problem at random, but that day seems farther and farther off the more we learn of the intricacies of life. What we need today are techniques for digging out worthwhile problems, without depending entirely upon intuition.

The basic data on which I have based deductions about *T. mexicanus* come from the correlation of notes in my field catalogs supplemented by examination of specimens and some experimentation in the laboratory. In accumulating the mass of field notes I have, following a precept of Rogers, asked myself every question I could think of about every situation in which I have collected. The answers to these questions *are* my field notes. The questions concentrate on two concepts: (1) Can I detect anything I can equate with *major habitat*? (2) Are there local details which indicate more specific relationships of the organism with this environment? Or in other words, what are the *minor habitats* or subdivisions of this situation?

Much of the information acquired in this way is probably utterly worthless. Some is too subjective to quantify; some seems to have no bearing on any problem in which I am interested. As far as I can find, however, no one has found a better way to start digging into a complex problem involving a single species, an association, or a region.

I hope that I have been able to point out in the preceding discussion some of the kinds of problems to which the habitat-approach may contribute. The fact that neither the approach nor the problems are currently in style in ecology seems to me wholly immaterial.

We can, of course, approach biological problems from other directions and on other levels. We can completely generalize the concept of habitat by defining it as a portion of the biosphere in which the physical and biotic factors are such that the organism or organisms with which we are concerned can establish, maintain, and reproduce a population. We ought to realize, however, that this is a generalized inductive abstraction which was derived from a mass of data accumulated on an entirely different level. The question is not whether the definition is sound, but whether it can be used as a basis for further investigation.

In contrast, the concept of major habitat is an abstraction at quite a different level. Our primitive ancestors must have clearly perceived the correlation between the occurrence of certain animals and various types of terrain and vegetation, because such perception was vital both from the point of view of food getting and survival. Many living men develop a remarkable ability to recognize the probable habitats of certain animals in which they are interested, and although this "art of the hunter" is difficult to explain the investigations of modern psychology indicate that it is essentially a learning process involving inductive-deductive reasoning.

Unfortunately, the process by which such discriminations are made are usually not recognized by the subject. The result is that there is little possibility of standardization in any scientific way until we know considerably more about the learning process involved. Nevertheless, the breaking up of a complex area into subdivisions for the purpose of preliminary investigations of the fauna and flora is invaluable as a starting pont, and a highly subjective "feeling" for "habitat" has been the classical approach to descriptive ecology.

In order to subdivide the environment with some greater degree of objectivity, however, we need to recognize some general criteria for the recognition of subdivisions. It seems obvious that a general definition of habitat is on too high a level—a level on which we simply cannot work in our present state of ignorance about physiological tolerances and biotic interrelationships. We need a tool which does not rely initially upon detailed information, unless we are content to await the accumulation of the necessary facts.

The concept of major habitat has served for many years as such a tool for the study of both individual species and communities. In a restricted sense we may define it as *a typical, more or less frequent, feature or complex of topography, drainage, soil, and vegetation* (Rogers, 1933). I would qualify this only by adding that the unit should be refined as far as available data permit. We must keep in mind in using such a unit concept, however, that we have abstracted a portion of the total environment and induced an apparent stability in a dynamic process; and we should be ready to abandon our brainchildren when a better way of dealing with the facts is found.

Furthermore, we should realize that our concepts of major habitats must be derived for a particular area and for a specific purpose. The unreality of specific examples becomes apparent when we try to transfer them from one region to another. The discovery that the major habitats of water beetles as I conceive them in Florida is only vaguely applicable to conditions in Michigan and Indiana does not bother me, because I realize that in the first place I was seeking a means of simplifying a complex of factors the permutations and combinations of which must be almost infinite. They do give me basis for comparison. It is too much to expect that any two natural situations even within a small area are exactly alike in all respects because the ecological relationships of organisms have time as well as space depth. We can only hope to catch certain situations in a state which may be partially repeated in time under the general conditions of the region.

The test of a tool, however, is not whether it can do everything, but whether or not it can produce the end results for which it was intended. In this respect the concept of major habitat needs further testing, but it has already made valuable contributions in the organization of great numbers of facts. Much of the material in the *Naturalist's Guide to the Americas* (1926), for example, is organized around major habitats or natural regions. The value of such a work cannot be denied, even if we question its philosophical basis. It is only unfortunate that there are not more such outlines to help the field ecologist to select the problems worth attacking.

The major habitat concept is most valuable in dealing with large animals and with vegetation. With smaller animals we need a more refined tool. This is particularly true if we are concerned with the distribution and abundance of species. The *specific habitat* (Rogers, 1933) and the *characteristic minor habitat* seem to be useable concepts in regard to specific organisms. When conditions are such that minor habitats are regularly telescoped upon one another or are bound together in some way, the *micro-habitat* of Shelford is applicable.

In regard to species or closely related groups the minor habitat concept involves the assumption that *every organism has some particular set of environmental conditions under which it best establishes, maintains, and reproduces a population.* The further assumption that minor habitats like major habitats can be recognized by indicator conditions is inherent in the idea and distinguishes it from the *niche* of Elton. In a sense, the major habitat serves as a matrix in which minor habitats are enclosed. The occurrence of a major habitat, however, does not assure the occurrence of a particular minor habitat, nor can the reverse be proven.

The assumption on which the minor habitat concept is based can be tested to some degree by making logical deductions about the consequences and checking them against observed conditions. For example, we generally make the observation that when mosquitoes are abundant in a situation, some suitable breeding place (minor habitat) is close by. This assumption of a specific minor habitat for each species has been widely used in malaria control with great success. In many other cases both frequency and abundance of organisms can be directly correlated with the occurrence of specific habitats. The reverse of this process is, of course, the inductive basis of the concept.

It is repeatedly observed with water beetles that certain types of situations are regularly correlated with the occurrence of certain species or groups of species. For example, in Michigan *Agabetes acuductus* occurs frequently and abundantly in seasonal woodland pools where decaying deciduous leaves are abundant. It also occurs frequently but less abundantly in the shaded margins of swamps, bogs, and larger bodies of water where small local areas present conditions of leaf-fall and shading similar to those in the woods ponds. In western Florida, over a thousand miles to the south, *Agabetes acuductus* occurs in very similar woods pond situations in association with a number of other typical woods pond species also found in Michigan, (Young, 1955).

The repeated observation of correlations such as those cited above leads to the assumption that similar minor habitats may occur even in places where they are not recognizable by indicators. They may be interrelated as zones, patches, or mosaics in complex major habitats, and in aquatic beetles this may be the explanation of the occurrence in close spatial proximity of species which seem to occupy identical ecological niches.

J. R. Zimmerman (unpublished ms.) has recently been able to show that beetles of the genus *Laccophilus* show distinct "habitat preferences" even when several species occur in the same small pond. That is, the distribution is not random even within a very small aquatic situation, but can be correlated with depth of water, type of bottom, and other recognizable features even though the "ultimate" causes of the restrictions are not yet apparent.

In most natural situations ecological relationships are so complex that any attack which offers the possibility of simplification for initial analysis seems worth trying. Elton (1927) and others have pointed out that the inter-relationships of many organisms are most profitably studied on small islands, in the arctic, or under other extremes of environmental conditions. The minor habitat often presents extreme conditions, and it is perhaps for this reason that the study of certain extreme situations such as those of bogs, brackish water, and cold and hot springs has proven profitable in understanding the distribution of certain species.

Paulian (1948) has arrived at a very similar conclusion in regard to the usefulness of the minor habitat concept. Unfortunately, he uses terms which make a confusion with the *ecological niche* of Elton inevitable, and although it seems niche and minor habitat overlap I do not think that the two should be equated at present. Minor habitat might be thought of as a tool for studying the niches occupied by species.

We might analogize the total ecosystem of the earth with a great tangled ball of yarn. The tangle results from the reactions, coactions, and interactions of a complex of physical and biotic factors acting upon a complex of living organisms dynamically adjusting in both space and time. In working with this tangle, the major habitat concept helps us to subdivide the ball, and the tag ends of minor habitats which stick out here and there allow us to make some further analysis. Eventually with the extension of these tools and the addition of others we may hope to understand, if never to analyze in detail, the central tangle.

The danger lies, as others have pointed out, in letting our investigatory fire run too lightly over the surface without ever penetrating beneath it. If we content ourselves with superficial listing and description, the preoccupation with habitat can prove completely sterile.

LITERATURE CITED

ELTON, CHARLES

1927. Animal ecology. Sidgwick & Jackson, Ltd., London, (3rd impression, 1947) pp. xx + 209, illus.

PAULIAN, R.

1948. Notion, limites, et importance des niches écologiques. *Rev. fr. d'Entom.* 15 : 161-165.

ROGERS, J. S.

1933. The ecological distribution of the crane-flies of Northern Florida. *Ecol. Monogr.* 3 : 1-74, illus.

1942. The crane flies (Tipulidae) of the George Reserve, Michigan. *Misc. Pub. Mus. of Zool., Univ. Michigan No. 53.* pp. 128, illus.

SHELFORD, V. E. (editor)

1926. Naturalist's guide to the Americas. Williams & Wilkins Co., Baltimore, pp. xv + 761, maps.

YOUNG, F. N.

1955. A preliminary survey of the water beetle fauna of Glen Julia Springs, Florida. *Quart. Jour. Florida Acad. Sci.,* 18 (1) : 59-66.

A REPORT ON SUCCESSION STUDIES OF SELECTED PLANT COMMUNITIES ON THE UNIVERSITY OF FLORIDA CONSERVATION RESERVE, WELAKA, FLORIDA

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University of Florida

INTRODUCTION

This study of the plant communities of the University of Florida Conservation Reserve was begun in December, 1939. I am much indebted to J. Speed Rogers for the interest and encouragement he gave toward the initiation and completion of my dissertation on this subject which was published in July, 1942. My interest in plant communities and their succession in Florida has been continuous since then, but field work on the Reserve was limited largely to irregular observations until September 1951, when permanent quadrats were set up on selected sites. I regret that permanent quadrats were not constructed in 1939 when my studies began. I can only say that I then had no idea that I would remain in this general area nor did I know that I would have any opportunity to continue this study on the Reserve.

PERMANENT QUADRATS

Permanent quadrats are set up in the following manner and involve the following considerations:

1. *Size*—Inasmuch as trees and shrubs were the main vegetation studied all quadrats are at least 100 x 100 feet. One, 160 x 160 feet, was made because it contained many large and widely spreading live-oaks.
2. *Location*—The location of quadrats was chosen by estimating examples of typical communities as exemplified at their time of classification given by Laessle, 1942. Wherever such examples were satisfactorily represented within one of the four inviolate areas of the Reserve, they were so located, but two, one in a mature live-oak hammock, and one a black-pine and fetterbush flatwoods, are located in non-inviolate areas. The quadrats are clearly marked and designated as inviolate.

3. *Marking*—Concrete posts measuring 4 x 4 inches and 3 feet long were set at the corners of each quadrat, leaving the upper foot above ground level. Where the quadrats were located at considerable distance from obvious reference points, bearings and measured distances were taken from such obvious reference points as road or fence intersections. These data were recorded and plotted on a map of the Reserve.
4. *Mapping and vegetation*—In order to get a fairly accurate map of the woody species within the quadrats the area was laid off in twenty foot squares by running twine at twenty foot intervals from two adjacent sides to their opposite sides. The approximate position of each plant was then mapped using different symbols for each species. When the diameter breast high was an inch or more this D. B. H. was recorded to the nearest inch, either within the symbol or close enough to it, to indicate definitely to which symbol the figure refers (Fig. 4). This should enable one to record, not only of the rate of growth of each tree, but also of those which succumb and new invaders as well. I have not decided how often it will be advisable to re-map these quadrats, but time intervals for profitable re-evaluations will no doubt vary in different sites having variable rates of succession.
5. *Herbaceous vegetation*—Only lists of the more important herbaceous species and vines were made. This data is omitted in this reoprt.
6. *Soil profiles*—One soil profile was made from a recorded corner of each quadrat. A soil auger was used to get this record to a depth of four feet. No subsequent comparisons have yet been made as six years is probably much too short a time to yield any recognizable changes.
7. *Photographs*—Photographs of each quadrat were made from recorded positions, (Figs. 1 and 2). Dated negatives are in my files.

Findings and Interpretations

Quadrat 1

This quadrat, measuring 160 feet per side, is located in what I classified as xeric or live-oak hammock (Laessle, 1942 : 36) and has

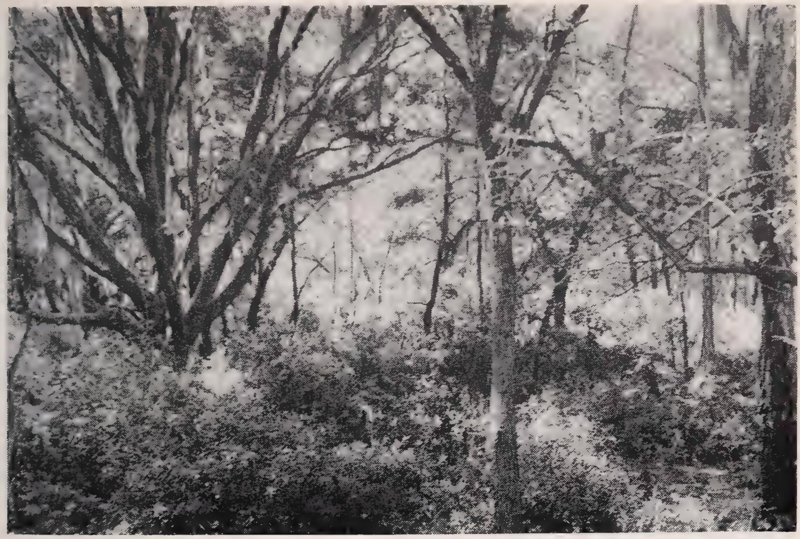

Figure 1. Facing S.E. toward the W. corner of Quadrat No. 1. This photograph was taken in May, 1942. Fire protection had been in effect since 1935. Notice the small amount of Spanish-moss. The ground cover is mostly myrtle-oak.

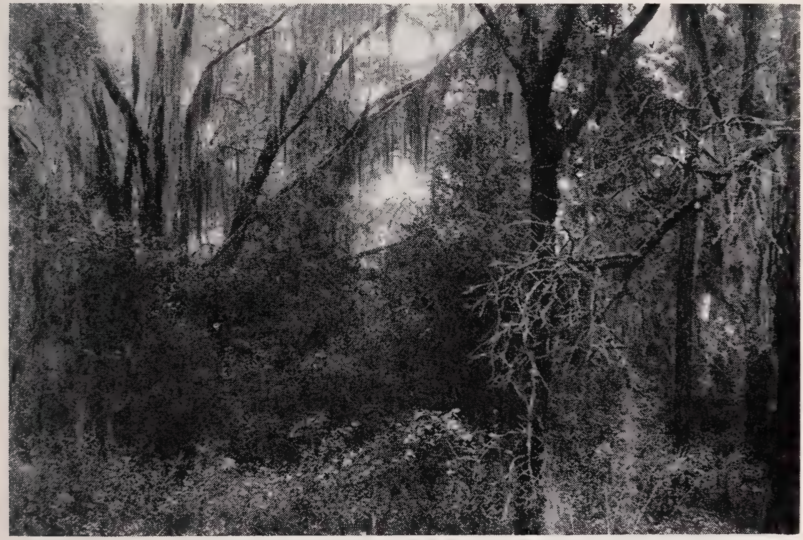

Figure 2. This photograph was taken from the approximate position as the above, in October 1956. In addition to the great increase of Spanish-moss, notice the increase in the height of the myrtle-oaks, laurel-oaks are now evident just to the right and left of the center.

not been burned since 1936. Prior to this time fire had been of almost yearly occurrence. Tabulation of the principle tree species in D. B. H. is given in Table 1 below.

TABLE 1

D.B.H. inches	Live-oak	Laurel-oak	Myrtle-oak	American-holly	Slash-pine	Swamp red-bay	Longleaf-pine
< 1	4	44	very abundant	4	2	2	1
1	2	37	12	1	1	0	0
2	0	20	3	5	0	0	0
3	1	11	0	1	0	0	0
6	6	0	0	0	0	0	0
7	4	0	0	0	0	0	0
8	4	0	0	0	0	0	0
9	7	0	0	0	0	0	0
10	5	0	0	0	1	0	0
11	6	0	0	0	0	0	0
12	3	0	0	0	0	0	0
13	5	0	0	0	0	0	0
14	4	0	0	0	0	0	0
15	3	0	0	0	1	0	0
17	3	0	0	0	0	0	0
18	1	0	0	0	0	0	0
20	1	0	0	0	0	0	0
25	1	0	0	0	0	0	0
27	1	0	0	0	0	0	0
31	1	0	0	0	0	0	0

The number of individuals falling into each D.B.H. is given under the species name at the top of each column. Young cabbage-palms, (*Sabal palmetto*) were abundant but are omitted here as none had trunks of breast height.

Some speculation regarding the history of this site before fire protection was initiated in 1935 seems appropriate. There are some very large longleaf-pine stumps present and some of the larger live-oaks must be at least one hundred years old. These facts, plus the fact that the hammock is roughly circular in shape rather than the typically rectangular outline characteristic of cultivated fields, makes it seem unlikely that the area was ever cleanly cultivated. The low widely spreading branches of the live-oaks, (Fig. 1), indicate that these trees underwent early growth either in the open or under a rather open canopy. Either of these conditions may have been created well over a hundred years ago when the region was first lumbered. This part of Florida was fairly well settled in Bartram's time (Bartram, 1791). It seems likely that the site had been subject to fires from both lightning and man for a very long time, and that the dominant vegetation was once longleaf-pine with an understory of small live-oaks (*Quercus virginiana*) and myrtle-oaks (*Q. myrtifolia*).[1] Even before the cutting of the pines it is probable that occasional very severe fires occurred, killing most live and myrtle-oaks to the ground, but leaving the larger longleaf-pines unharmed. Sprout growth from the oaks would grow until another fire. Once-in-a-while, due to chance, a live-oak would attain such size and thickness of bark to be fire resistant enough to reach maturity. Many of the present live-oaks bear fire scars.

Analysis of Table 1 shows that the more fire susceptible species, especially laurel-oaks (*Q. laurifolia*), have invaded the site in great numbers. Increment borings of the largest laurel-oaks showed them to be about twenty years old, or to have existed just about the length of time since the last fire. There is no evidence that any of this species are from sprout growth. An attempt to date the last severe fire by counting the rings that have accumulated in the overgrowth of the partially healed-over fire faces of the live-oaks failed because of the difficulty of recognizing growth rings in this species.

One of the most puzzling aspects of the quadrat is why the live-oaks are not reproducing. In good seed years, the ground is almost covered with viable live-oak acorns. Lack of sufficient light under the thick canopy might be considered the critical factor, however, there are a number of openings in the canopy which receive at least one-half full sunlight, still there is no live-oak reproduction here. Perhaps the answer lies in the severity of root competition?

Another question which arises is the paucity of holly, (*Ilex opaca*) and complete lack of magnolia, (*Magnolia grandiflora*) and other components of the mesic hammock (Laessle, 1942 : 37) in comparison to the large number of recently invading laurel-oaks. This I believe to be due to chance, as mature laurel-oaks are abundant in the nearby mesic hammocks bordering the St. Johns River, while mature trees of holly and magnolia are both farther away and fewer in number. The presence of swamp red-bay (*Tamala pubescens*) normally a swamp of bayhead species, in such a well drained site is surprising. Observations at the Reserve show that other characteristically hydric species as swamp-maple, (*Rufacer rubrum*) and whitebay (*Magnolia virginiana*) are invading drier sites than those in which they are usually found. I believe that their usual restriction to hydric situations is primarily due to their susceptibility to fire rather than their need for abundant water. It seems that red-bay (*Tamala borbonia*), a characteristically mesic hammock species, would be more likely to invade this site. I believe it would, other factors being equal, but the swamp red-bays are abundant in a nearby bayhead only five hundred feet away, while mature red-bays are at least a mile distant.

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[1] Nomenclature follows Small, 1933.

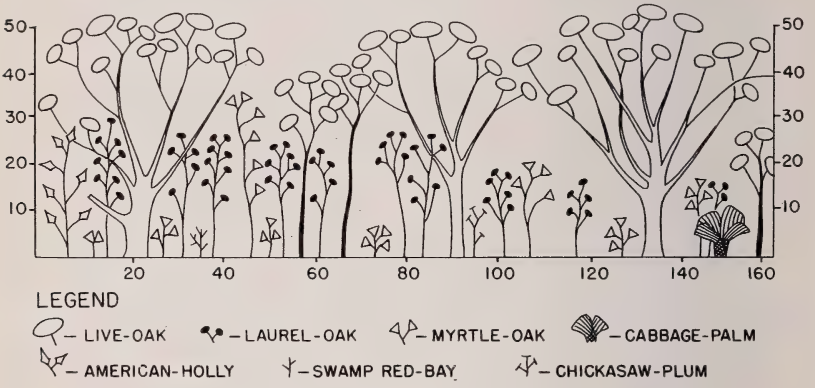

Figure 3. This profile includes a strip about twenty-five feet wide along the N. W. side of Quadrat No. 1. Small sprouts of myrtle-oak, small cabbage-palms and vines are omitted. Numerals are in feet. Sketched October, 1956.

Quadrat 2

This quadrat is in what was classified as the *Pinus australis-Quercus cinerea* Association (Laessle, 1942 : 35). When my first study of the Reserve was made, this site contained numerous live-oaks, the larger only five to six feet tall. Next to Quadrat 1 above, this shows more rapid successional change than any other of my permanent quadrats. Here the soil is similar to that of Quadrat 1, Blanton fine sand. The topography is also similar, being surrounded by slightly lower longleaf-pine flatwoods, except on the east, where it merges with scrubby flatwoods (Laessle, 1942 : 29-30). The following Table was derived from the mapped quadrat Fig. 4.

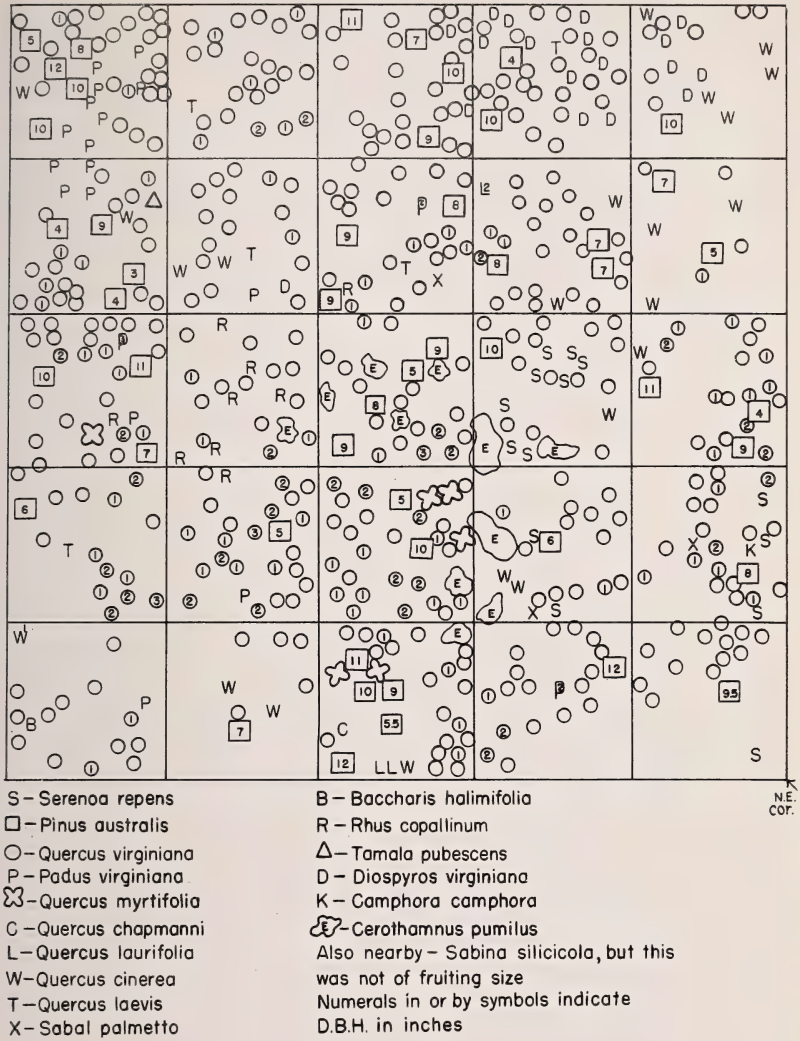

Figure 4. Map of Quadrat No. 2 showing the approximate position and D.B.H. of trees and shrubs. Clump outlines rather than individual stems are used for the root-sprouting wax-myrtle. The smaller squares measure twenty feet per side.

In addition the following species, all with a D.B.H. of less than one inch were: *Cerothamnus pumila*-11 clumps, *Diosypros virginia*-14 small stems all within a radius of twenty feet and probably all sprouts from a single root system, *Rhus copallinum* - 7 stems, probably root clones, *Tamala pubescens* - 1, *Camphora camphora* - 1, *Serenoa repens* - 12 small clumps, *Quercus chapmanii* - 1, *Sabal palmetto* - 1.

TABLE 2

D.B.H. (inches)	Longleaf pine	Live-oak	Black-cherry	Laurel-oak	Bluejack oak	Turkey-oak
< 1	0	321	10	2	20	4
1	0	60	0	0	1	0
2	0	30	2	1	0	0
3	1	3	1	1	0	0
4	4	0	0	0	0	0
5	6	0	0	0	0	0
6	2	0	0	0	0	0
7	6	0	0	0	0	0
8	5	0	0	0	0	0
9	9	0	0	0	0	0
10	9	0	0	0	0	0
11	4	0	0	0	0	0
12	3	0	0	0	0	0

Table 2 is deceptive in the apparently great number of live-oaks—most stems are root clones.[2] Further analysis shows that longleaf pine have not reproduced since the last fire about 20 years ago, or shortly thereafter. One can easily visualize that this quadrat would, in the continued absence of fire, develop into something similar to Quadrat 1 except that there would be a marked telescoping of stages—exemplified by some laurel-oak being as large as the largest live-oak.

---

[2] As most observers in this region have no doubt noticed, live-oak is a very heterogeneous species and, in my experience, even genetically identical specimens are markedly modified morphologically in different environments. A number of years ago I transplanted from the Reserve scrub a typical example of the strongly revolute margined, strong veined form, which Small named *Q. geminata*, to a mesic hammock near Gainesville, Florida. All leaves formed in the new habitat were nearly flat with scarcely revolute margins. An additional observation as to the plasticity of the some of its verieties occurred in the study of my permanent transect in the longleaf-pine flatwoods (Laessle, 1942:43). Dwarf live-oak [*Q. minima* (Sarg.) Small] was once common in this habitat. When my transect was mapped in 1951 examples of this species were absent, but there were scattered small live-oaks up to six or eight feet tall. In April, 1956, a severe fire killed all this vegetation to the ground. On a visit to this spot on October, 1956, there were new sprouts from the burned root-stocks. All showed the characteristic toothed leaves of *Q. minima*, while the charred six to eight foot stems of what could only fit *Q. virginiana* before the burn, were still sticking up from the same rootstocks. So, in my opinion, *Q. minima* is merely a fire and flatwoods ectotype of a freely root-sprouting variety of *Q. virginiana*.

The naturalized species camphor, (*Camphora camphora*), while scattered, is apparently destined to become an important element in the development of the Reserve's hammocks—providing that fire is eliminated. The same may be said for most of the northern and central Florida.

It is my belief that the small blue-jack oaks and turkey-oaks in this quadrat will soon succumb to the severe competition for light, water, etc., which, while severe now, will become increasingly so in the future. Why invading laurel-oaks do not occur in as large number as found in Quadrat 1 is not apparent to me. The proximity of seed trees of this species is certainly as favorable here as it is there.

Many of these quadrats show very little successional change at this time. A quadrat in the sandhills Longleaf-pine—Turkey-oak Association, (Laessle, 1942 : 30) showed practically no evidence of invading species except five sand-pine (*P. clausa*). The larger two had a D. B. H. of five inches. Some small magnolia were noticed in nearby portions of the sandhills, outside the quadrat. In order to get some sort of estimate of their rate of invasion, an area much larger than my quadrat, but including it, was sampled by walking in parallel lines spaced one hundred feet apart and counting invading species fifty feet to each side of these lines. As ground cover was very sparse, and larger vegetation widely spaced, I feel certain that no invading species over a foot tall was missed. An area of roughly thirteen acres was covered in this manner, and the following number of invading species recorded: Sand-pine—35, magnolia—5, black-cherry—2, Chapman's-oak—2, wild-olive, (*Amarolea americana*)—1, cabbage-palm—1 (small), camphor—1. Live-oak is not considered an invader, as small trees and sprout growth are characteristic of this association even when burning is frequent. All of the invaders, except the cabbage-palm, are intolerant of fire and would not occur in a longleaf-pine—turkey-oak community exposed to the almost annual burning which has obtained in Florida.

The southern portion of this thirteen-acre area is within about a quarter of a mile north-east of a mesic hammock containing many mature magnolias. It was noticed that four of the five invaders of this species were in the southern half of the area. The nearest mature sand-pines were about the same distance south of the area. No mature camphor trees are known to occur within at least a mile, but as the pits of this species and of the black-cherry are transported by birds, their migration to this area is understandable. The peculiar thing, in the light of the very rapid invasion of the laurel-oaks in Quadrat 1, is that no laurel-oaks have invaded here, though mature trees of this species are abundant within a third of a mile to the south. I have no doubt that many laurel-oak acorns have been transported to the area, probably more of them than magnolia seed. Laurel-oak is frequently one of the first invaders in the long-leaf-pine-turkey-oak (generally Lakeland soils) around Gainesville. I am aware of no environmental factor which would prevent the establishment of this species on the Reserve's Lakeland soils unless some critical element is lacking. No significant difference in either the macro nor micro-elements found in Blanton fine sand, the series of soil in Quadrat 1, and Lakeland of the same texture, was apparent in (Gammon et al, 1953). In fact there was often more variation in these elements in examples of the same series than in selected examples from the two series. Analyses of soil samples from the Reserve might give more conclusive information.

The demonstrated ability of magnolia to become established on the excessively drained poor sands of the Reserve's sandhills does not seem so surprising when it is realized that is common in the dunes of western Florida (Kurz, 1942). It is apparently tolerant to both strong light and deep shade, and is able to survive with meager amounts of those nutritional elements generally required in plant nutrition, but its rate of growth is much retarded in poor soils.

Reports on successional studies from other quadrats of the Reserve must await more conclusive changes in vegetation. Changes in soil profiles will no doubt lag behind vegetational changes for variable lengths of time but I hope that at least some of these will be evident during whatever time is alloted me to continue this study.

Observasions and Generalizations

A number of scattered observations concerning plant succession on the Reserve seem worthy of presentation. During the twenty years of fire protection there has been a surprisingly rapid spread of red-maple from its former confinement to river swamps to the flatwoods, particularly to those portions adjacent to the swamps.

The absence of fire has also permitted a considerable extension of the bayhead flora, especially loblolly-bay (*Gordonia lasianthus*), to the moister portions of the flatwoods. This substantiates my hypothesis (Laessle, 1942 : 103), that in the absence of fire, bayhead species would invade the lower, more moist portions of the flatwoods. There is also increasing substantiation of my opinion that the drier portions of the flatwoods are being invaded by hammock species, particularly live-oak, although a number of magnolia and swamp red-bay have been observed growing well in this habitat. The magnolias are doing much better here, as individuals, than in the sandhills. A number of trees six to seven feet tall were observed here, while the largest sandhill specimens are scarcely three feet tall.

A Look into the Future

Unless fire or some unnatural disturbances take place, the Reserve's quadrats should not only yield definite information regarding the stages of plant succession on most of the soil series of peninsular Florida, but should also yield a fairly accurate measure of the rate of these changes. I expect that, as invading species reach seed bearing size or age, the rate of succession should accelerate, not only because of the increased number of seed produced, but also because of soil changes which should also accelerate as more and more invaders modify the areas. As succession progresses the sharp ecotones between the predominantly fire climax communities obtaining when I first studied the Reserve should become broader and less clear cut. Indeed this tendency is already apparent in some areas. I do not expect that, even within a thousand years, the vegetation will become homogeneous throughout including the better drained areas of flatwoods, sandhills, hammocks and scrub. I believe that a mesophytic hardwood climax would develop in all these situations. I am a supporter of the polyclimax concept. It does not seem possible, for instance, that soils derived from deposits of nearly pure sand could ever support a flora even approximating that derived from limestone, or limy materials such as the shell mounds at Orange Point (Laessle, 1942 : 59-60). Observations of almost undisturbed calcareous climax hammocks to the west and southwest of Gainesville show them to have considerable numbers of such trees as box-elder (*Negundo negundo*), hammock-maple (*Saccharodendron floridanum*) and Shumard's-oak (*Q. shumardii*), in addition to the species characteristic of the sandy mesophytic hammocks of the Reserve. The calcareous hammocks also have a noticeably higher component of deciduous elements than do any of the sandy hammocks observed in the northern and central parts of peninsular Florida. Such observed floristic differences, while in part probably influenced by the higher pH of the calcareous soils, are no doubt also influenced by the generally richer and more clayey nature of these soils.

The effects of chance will be more pronounced in the early vegetational changes following both fire climaxes and secondary successions. This is particularly obvious when one considers the comparative scarcity and generally widely separated stands of most of the climax associations—both on the Reserve and in most of peninsular Florida.

Literature Cited

BARTRAM, WILLIAM
1791. Travels through North and South Carolina, Georgia, East and West Florida. Philadelphia.

GAMMON, NATHAN ET AL
1953. Physical, spectographic and chemical analyses of some virgin Florida soils. Univ. of Fla. Ag. Exp. Sta., Tech. Bull. 524.

KURZ, HERMAN
1942. Florida dunes and scrub, vegetation and geology. Fla. Geol. Surv., Geol. Bull. 23, Tallahassee, Fla.

LAESSLE, A. M.
1942. The plant communities of the Welaka area, with special reference to correlations between soils and vegetational succession. Univ. of Fla. Publication. 4(1).

SMALL, J. K.
1933. Manual of the southeastern flora. Science Press Printing Co., Lancaster, Pa.

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Contents

Caldwell—Fossil Fish Teeth of the Family Sparidae from Florida 113
Caldwell—A New Fish of the Genus *Ophioscion,* Family Sciaenidae, from Caribbean Costa Rica 117
Myers—Notes on the Eggs and Larvae of *Eurycea lucifuga* Rafinesque 125
Sakuntala, Argus, and Ray—Dosimetry Determinations of Gamma Rays in an Underground Co^{60} Source 131
Caldwell—Notes on the Barred Pattern in the Sheepsheads, *Archosargus probatocephalus* and *A. oviceps* 138
Phillips—Notes on the Development of *Anadyomene stellata* (Wulf.) C.AG. 145
Pirkle—Lithologic Features of Miocene Sediments Exposed in the Devil's Mill Hopper, Florida 149
Sandberg—The Problem of Bias on the Part of the Researcher in the Social Sciences 162
Auffenberg—A New Family of Miocene Salamanders from the Texas Coastal Plain 169
Godfrey—A Synopsis of *Gnaphalium* (Compositae) in the Southeastern United States 177
Phillips—Extension of Distribution of *Ruppia maritima* var. *obliqua* (Schur.) Aschers. and Graebn. 185
Clark—Jellied Condition in *Paralichthys squamilentus* from the Gulf of Mexico 187
Research Note—Additions to the Fishes of Cedar Key, Florida, and a List of Gulf of Mexico Carangidae 190

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FOSSIL FISH TEETH OF THE FAMILY SPARIDAE FROM FLORIDA

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and The Florida State Museum

From a Pliocene locality in Florida I recently reported and figured (Caldwell, 1957: 151) two fossil fish incisor teeth referred to the sparid genus *Lagodon* Holbrook, and tentatively ascribed to the species *Lagodon rhomboides* (Linnaeus). This deposit, near the village of Haile, Alachua County, Pit VI, A, located in SW ¼, Sect. 24, R. 17 E., T. 9 S., is in the Alachua formation and is considered to be Middle Pliocene (Hemphillian) in age (Auffenberg, 1957: 14). The locality is thought to be of freshwater origin (Goin and Auffenberg, 1955: 500, 503), and more especially, a sinkhole or fluviatile deposit (Auffenberg, 1955: 135). Because of the presence of *Lagodon*—a marine species known to ascend into fresh water—I proposed (Caldwell, 1957: 152) that the deposit might represent an ancient spring or stream near the seacoast. I also suggested, after consultation with Dr. Auffenberg, that perhaps the sparid teeth were residua from a slightly older marine deposit reworked by the fresh water or that they were deposited during a short-term marine inundation soon after the original freshwater deposit was laid down. The teeth do not indicate long-term water-wear and their condition is quite similar to that of freshwater fossils from the deposit, though it cannot certainly be said that they are of exactly the same age or from identical ecological conditions.

Careful working of this same deposit by Dr. Auffenberg has now yielded two other types of fossil fish incisor teeth which can also be referred to the family Sparidae (see Caldwell, 1957: 153, for a

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detailed discussion of teeth in this family, and the choice of eligible genera within the family).

The first form of the recent finds, and apparently the most common of all three in the deposit, are best assigned to the genus *Diplodus* Rafinesque. There are 11 of these teeth in the University of Florida Collections (UF 6587), measuring 1.8 to 2.2 mm. in greatest width. I have described and illustrated modern teeth of this genus (Caldwell, 1957: 154). Although their bases are broken, all of the fossil teeth possess the remnant of a buttress at the base of the inner surface (Figure 1). Also like modern *Diplodus* teeth these fossils have a smooth cutting edge which is strongly slanting upward toward one corner, and they are somewhat rectangular in anterior aspect above the buttress. Though similar to the incisors of modern *Archosargus probatocephalus* (Walbaum), these fossil ones are more strongly incurved in lateral profile—more like those of *Diplodus*—and in anterior profile are broader in relation to their height above the buttress than are those of *A. probatocephalus* (see Caldwell, 1957: 155 and Figures 20-21). Two species of *Diplodus, D. holbrooki* (Bean) and *D. argenteus* (Valenciennes)[2], are presently known from Florida, but their teeth are apparently identical, and no specific name is suggested for the fossils. *Diplodus* is less likely to be found in fresh water than *Lagodon* (see Caldwell, 1957: 154), and the presence of these teeth in the deposit strongly indicates a marine origin for the sparid teeth, and thus the representation in the deposit of two time periods and ecological conditions.

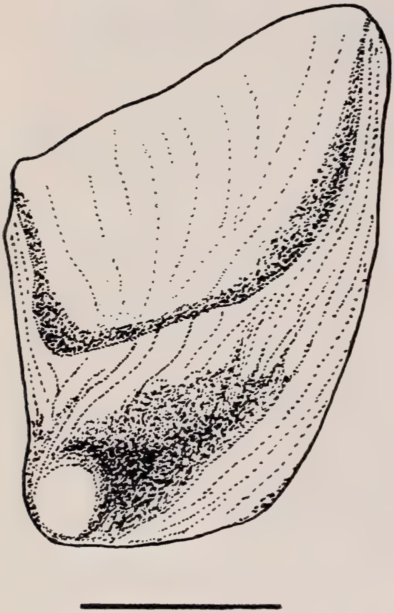

Figure 1. Fossil fish incisor tooth referred to the genus *Diplodus* of the family Sparidae. Line indicates 1 mm.

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[2] In citing a single author I follow Bailey (1951: 249).

In the second type of sparid incisor tooth recently found in the deposit the bases are also broken, but enough remains to indicate that they were buttressed as those described for *Diplodus*. Their cutting edges are smooth and only slightly slanting toward one upper corner, and the teeth are square in anterior profile above the buttress (Figure 2). In this squareness they are unlike modern *Diplodus* and *A. probatocephalus* teeth, but are similar to those of *A. rhomboidalis* (Linnaeus) and *A. pourtalesii* (Steindachner), (see Caldwell 1957: 155). However, they are not as strongly incurved in lateral profile as those of these latter species, and though a few may be entire (Caldwell, 1957: 155 and Figure 22), most of the incisor teeth of *A. rhomboidalis* and *A. pourtalesii* have concavely lunate or slightly serrated cutting edges. While these fossils clearly belong to the family Sparidae, they can not presently be ascribed to a particular genus —the nearest modern incisor-toothed types apparently being those found in *A. rhomboidalis* and *A. pourtalesii,* neither of which is known from fresh water (Caldwell, 1957: 155). There are 7 of these fossil teeth (UF 6588), measuring 1.8 to 2.4 mm. in greatest width.

In addition to the three types of incisors, the Haile locality has

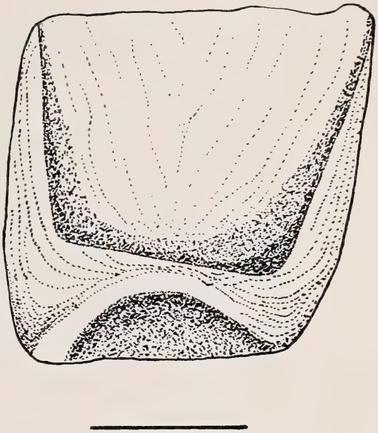

Figure 2. Fossil fish incisor tooth referred to the family Sparidae. Line indicates 1 mm.

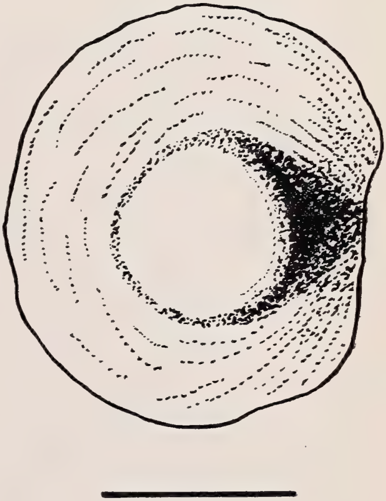

Figure 3. Fossil fish molariform tooth referred to the family Sparidae. Line indicates 1 mm.

produced six sub-circular molariform teeth (UF 6589) 2.1 to 2.7 mm. in greatest diameter. These teeth are of the type associated with the incisor teeth in members of the family Sparidae. Most of these molariform teeth are smooth on their upper surface, but several have distinct, rounded, teat-like projections (Figure 3) which are found on a few of the molariform teeth in some individuals of the genera *Lagodon, Diplodus,* and *Archosargus* Gill. Thus, while none of these fossil molariform teeth can be ascribed to a particular genus—since those of the above three named genera are so variable, within the same limits—they do add weight to the identification of the fossil incisor teeth as sparid, and provide further evidence that all three genera may be represented in the deposit.

I wish especially to thank Walter Auffenberg, of the University of Florida, for making available the fossil teeth reported here; for many suggestions made during the study; and for his critical review of the completed paper. The comments on the manuscript made by William W. Anderson, Frederick H. Berry, and Jack W. Gehringer, all of the United States Fish and Wildlife Service at Brunswick, Georgia, were most helpful.

Literature Cited

AUFFENBERG, WALTER

1955. Glass lizards (*Ophisaurus*) in the Pleistocene and Pliocene of Florida. *Herpetologica,* 11(2): 133-136.

1957. A new species of *Bufo* from the Pliocene of Florida. *Quart. Journ. Fla. Acad. Sci.,* 20(1): 14-20.

BAILEY, REEVE M.

1951. The authorship of names proposed in Cuvier and Valenciennes' *"Histoire Naturelle des Poissons." Copeia,* 1951(3): 249-251.

CALDWELL, DAVID K.

1957. The biology and systematics of the pinfish, *Lagodon rhomboides* (Linnaeus). *Bull. Florida State Mus., Biol. Sci.,* 2(6): 77-173.

GOIN, COLEMAN J., and WALTER AUFFENBERG

1955. The fossil salamanders of the family Sirenidae. *Bull. Mus. Comp. Zool.,* 113(7): 497-514.

A NEW FISH OF THE GENUS *OPHIOSCION*, FAMILY SCIAENIDAE, FROM CARIBBEAN COSTA RICA

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and The Florida State Museum

The fishes of Caribbean Central America, and particularly Costa Rica, are imperfectly known. Thus it was of special interest and significance to make a detailed study of a small collection of fishes recently received by the University of Florida Collections from Tortuguero, a small village on the northern coast of Costa Rica. The species and notes on the ecology of the fishes in this collection will be discussed in detail elsewhere (Caldwell, Ogren, and Giovannoli, MS). Among the marine fishes were two specimens of an undescribed species of the genus *Ophioscion* of the family Sciaenidae. This species may now be known as:

Ophioscion costaricensis, new species

Figure 1

Diagnosis

An *Ophioscion* (as defined by Schultz, 1945) with a very small eye—4.8 and 5.0 percent of standard length in specimens 110 and 117 mm. in standard length. Dorsal fin count X—I, 22-23; anal fin II, 9; 49 pored scales in lateral line; and 8 + 1 + 14 gill rakers on the first gill arch.

Description

To facilitate comparisons between *O. costaricensis* and the other Atlantic species of *Ophioscion,* as discussed by Schultz (1945), I have taken most of the measurements he included. These are presented as part of the description of *O. costaricensis* and appear in Table 1, along with the measurements based on Schultz for *O. microps* (Steindachner) and *O. brasiliensis* Schultz, its two closest relatives. Other, more subjective, characters of *O. costaricensis* are apparent from the photograph of the holotype which appears as Figure 1.

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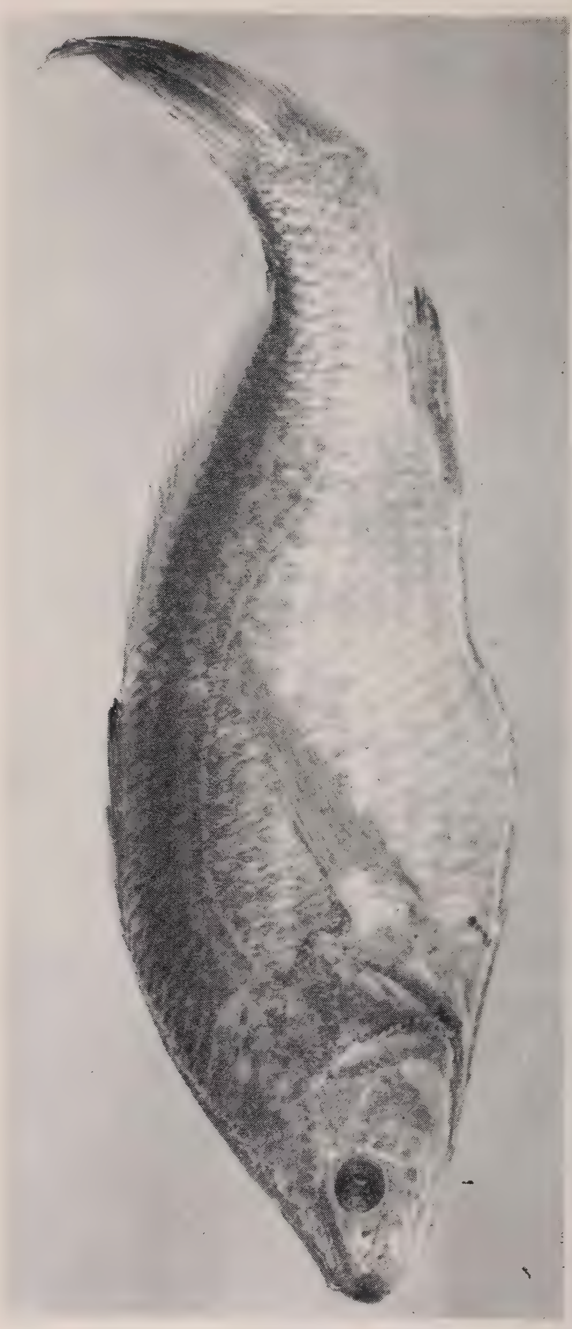

Figure 1. *Ophioscion costaricensis*, new species, holotype, 116.6 mm. in standard length, from Tortuguero, Caribbean coast of Costa Rica, Central America.

Characters not obvious from a study of the table and figure are: The ventral profile is nearly straight in the paratype (as figured for other species of this genus by Schultz 1945), and the protruding ventral outline of the holotype is an artifact of preservation. Tip of lower jaw without barbels. Pores on the tip of snout and lower jaw as described and figured for the genus *Ophioscion* by Schultz (1945). Pseudobranchiae well developed. Scales ctenoid. The more dorsal preopercular spines smaller than those nearer lower angle of preopercle; none hooked downward. Skull with cavernous spaces as described for this and other sciaenid genera by Schultz (1945). Teeth in villiform bands in both jaws, the outer ones of the upper jaw enlarged. Second dorsal spine slightly enlarged (heavier than the following ones). Second anal spine enlarged, but not reaching tips of soft rays. Posterior margins of dorsal and anal soft-rayed fins rounded; pectorals pointed. Posterior edge of spinous dorsal fin nearly straight. Mid-rays of caudal fin longest. Tip of filament of first pelvic soft ray reaching to anus; pectoral fins reaching beyond anus. Gill rakers short and slender, the longest equaling diameter of pupil.

COLOR

In alcohol, pale brown above, lighter below, with numerous tiny dark punctulations on scales except on ventral third of body of the holotype (missing only on most ventral part of body in the paratype—nearly covering the sides). Membranes and rays of dorsal and most of anal fins dusky, the last two anal rays and their membranes clear. Distal edge of spinous dorsal membrane nearly black. Inner ventral fin rays and membranes dusky toward their distal edges; outer rays and membranes dusky nearly to base of fin; filamentous first ventral ray white. Pectoral rays dusky and their membranes mostly clear. Caudal rays and membranes dusky.

RELATIONSHIPS

With the recent revision (Schultz, 1945) of the Atlantic species of *Ophioscion* and the detailed descriptions of the Pacific American forms presented by Meek and Hildebrand (1925) and Hildebrand (1946: 294), the relationships of *O. costaricensis* have a firm basis.

TABLE 1. PROPORTIONAL MEASUREMENTS (EXPRESSED IN HUNDREDTHS OF STANDARD LENGTH) AND COUNTS OF SELECTED SPECIES OF THE GENUS *OPHIOSCION*. THE DATA FOR *O. MICROPS* AND *O. BRASILIENSIS* ARE BASED ON SCHULTZ (1945). THE FIGURES IN PARENTHESES AFTER THE DATA FOR *O. COSTARICENSIS* ARE THE EMPIRICAL MEASUREMENTS IN MM. FOR EASE IN COMPARING ONTOGENETIC RELATIONSHIPS BETWEEN THE SPECIES, THE SPECIMENS ARE ARRANGED ACCORDING TO SIZE.

CHARACTER	*O. microps*		*O. brasiliensis*		*O. costaricensis*	
	A	B	holotype	paratype	holotype	paratype
Dorsal fin rays	XI—I, 21	XI—I, 19	X—I, 22	X—I, 21	X—I, 23	X—I, 22
Anal fin rays	II,9	II,9	II,9	II,9	II,9	II,9
Pectoral fin rays	ii,17-ii,16	ii,16-ii,16	ii,16-ii,17	ii,17-ii,17	ii,17-ii,17	ii,17-ii,17
Pelvic fin rays	I,5	I,5	I,5	I,5	I,5	I,5
Scale rows above lateral line to base of 1st dorsal soft ray	4	4	5	5	5	5
Scale rows above lateral line to dorsal origin	5	5	5	5	5	5
Vertical scale rows above lateral line	50	51	46	46	48	49
Pored scales in lateral line	—	—	45	46	49	49
Zig-zag scale rows around caudal peduncle	18	18	17	17	16	17
Scale rows between lateral line and anal origin	8	7	7	7	7	7
1st arch gill rakers	11+1+18	11+1+19	8+1+13	9+1+13	8+1+14	8+1+14
Preopercular spines	—	—	—	[9]	9	10
Standard length (mm.)	60.3	66.3	77	89	109.6	116.6
Head length	33.2	32.1	33.8	33.2	30.5 (33.4)	32.1 (37.4)
Greatest body depth	31.5	30.2	32.5	30.8	30.0 (32.9)	32.4 (37.8)
Diameter of eye	6.5	6.6	7.5	7.4	5.0 (5.5)	4.8 (5.6)
Snout length	8.6	9.9	9.2	8.8	8.7 (9.5)	8.3 (9.7)
Front of upper lip to rear tip of maxillary	11.9	11.3	12.2	11.8	10.2 (11.2)	10.9 (12.7)

Postorbital head length	19.1	18.5	18.8	18.4	18.8 (20.6)	19.0 (22.2)
Bony interorbital width	11.3	10.4	9.7	9.1	11.4 (12.5)	11.6 (13.5)
Base of last anal ray to midcaudal base (caudal peduncle length)	24.9	26.8	22.1	23.6	24.2 (26.5)	24.6 (28.7)
Least depth caudal peduncle	10.1	9.9	10.0	9.6	9.9 (10.8)	10.6 (12.4)
Length of second dorsal base	35.6	33.2	32.5	31.2	34.0 (37.3)	34.0 (39.7)
Length of anal fin base	12.6	12.5	12.5	12.9	12.0 (13.2)	12.2 (14.2)
Third dorsal spine length	19.8	19.6	17.5	—	16.2 (17.8)	18.2 (21.2)
Second dorsal spine length	13.4	14.0	12.3	11.8	11.5 (12.6)	11.4 (13.3)
Second anal spine length	18.6	18.1	16.2	13.8	15.6 (17.1)	15.7 (18.3)
Longest pectoral ray	25.7	21.1	24.4	22.5	25.0 (27.4)	27.1 (31.6)
Longest pelvic soft ray	23.7	23.1	25.1	25.8	22.2 (24.3)	24.9 (29.1)
Pelvic spine length	13.3	12.4	12.1	11.7	11.7 (12.8)	12.0 (14.0)
Longest midcaudal ray	—	—	26.0	23.0	28.4 (31.1)	27.8 (32.4)
Longest gill raker	2.7	2.7	3.6	2.8	2.8 (3.1)	3.1 (3.6)
Tip of snout to origin of spinous dorsal	38.1	36.9	37.1	36.5	35.5 (38.9)	36.9 (43.1)
Tip of snout to anal origin	66.8	65.4	68.3	70.8	66.2 (72.6)	67.2 (78.3)
Tip of snout to pelvic insertion	—	—	35.4	35.5	32.5 (35.6)	33.4 (38.9)
Tip of snout to pectoral insertion	33.3	32.1	34.4	33.7	30.3 (33.2)	31.8 (37.1)

The species of this genus are all quite similar in appearance, with the separations often based on relatively minor characters. Hildebrand (*loc. cit.*) has pointed out that the number of rays in the anal fin is constant within a species and that "the differences of a single ray in this fin apparently may be regarded as of specific importance." Schultz (1945) relied heavily on this character in separating the 7 Atlantic species in his key, although he found a single specimen of *O. panamensis* Schultz with an "off" anal soft-ray count. *O. costaricensis* differs from all other Atlantic species of the genus except *O. brasiliensis* and *O. microps* in having a II, 9 anal fin count. According to Meek and Hildebrand (1925), only *O. vermicularis* (Günther) of the Pacific species has a II, 9 count. *O. costaricensis* differs from *O. vermicularis* in having fewer dorsal soft rays; fewer lateral-line scales; the mid-caudal rays longest; a smaller eye; and other characters apparent from descriptions of the two forms. *O. costaricensis* differs from *O. brasiliensis,* as defined by Schultz (1945), in having a much smaller eye; greater bony interorbital; a slightly higher lateral-line count; a slighter longer second dorsal fin base, pectoral fin, and midcaudal fin rays; in addition to other minor proportional characters shown in Table 1. *O. costaricensis* differs from *O. microps,* as discussed by Schultz (1945), in having fewer dorsal spines; apparently averaging a slightly higher dorsal soft-ray count; fewer gill rakers on both the upper and lower limbs of the first gill arches; more scales between the lateral line and the base of the soft dorsal fin; fewer zig-zag rows of scales around the caudal peduncle; a smaller eye; shorter anal spine; a slightly lower soft dorsal fin; and other minor proportional characters shown in Table 1. Aside from the character of anal fin count, *O. costaricensis* differs from all other American species of *Ophioscion* in combinations of characters given in the descriptions of other species in Schultz (1945), Meek and Hildebrand (1925), and Hildebrand (1946).

When Schultz's key (1945: 126) to the Atlantic species of *Ophioscion* is utilized, *O. costaricensis* will insert in couplet three, between its closest relatives *O. brasiliensis* and *O. microps,* from which it has been distinguished in the above discussion. When the key to the Panamanian species of the genus is utilized (Meek and Hildebrand, 1925: 636), *O. costaricensis* would be identified as the Pacific form, *O. typicus* Gill, from which it differs in having more anal soft-rays and a smaller eye.

HOLOTYPE

University of Florida Collections (UF) 5831, 116.6 mm. in standard length, found dead on the open sea beach by Larry H. Ogren on July 15, 1956, at Tortuguero, Caribbean Costa Rica, Central America (latitude 10°34′ N., longitude 83°32′ W., approximately 52 miles northwest of Limon, Costa Rica).

PARATYPE

UF 5830, 109.6 mm. in standard length, found with the holotype.

REMARKS

Named *costaricensis* in honour of the country upon whose shores the specimens were collected.

The proportional measurements on *O. costaricensis* were made with the use of dial calipers calibrated to tenths of a millimeter. The last soft ray of the dorsal and anal fins is split to its base and was counted as one.

ACKNOWLEDGMENTS

Indirect support was received from the National Science Foundation in that Ogren was in Costa Rica as a Research Assistant working on the ecology and migrations of sea turtles under a grant from that organization (G-1684, University of Florida—Principal Investigator, Archie Carr). Teodoro Quiros C. of the Atlantic Trading Company at Tortuguero and Leo Martinez of that village were most helpful in cooperating with Ogren. Leonard P. Schultz of the United States National Museum was generous in making the paratype of *O. brasiliensis* and specimens of *O. typicus* available. Early in the study, Giles W. Mead, of the United States Fish and Wildlife Service, kindly made measurements and comparisons of the type material of *O. brasiliensis* and a specimen of *O. costaricensis*. Loren P. Woods of the Chicago Natural History Museum was generous in his encouragement. William W. Anderson, Frederick H. Berry, and Jack W. Gehringer of the United States Fish and Wildlife Service at Brunswick, Georgia, made many helpful remarks on the finished manuscript. Without the cheerful cooperation of Larry H. Ogren, the specimens would not have been procured for the University of Florida Collections.

LITERATURE CITED

CALDWELL, DAVID K., LARRY H. OGREN, and LEONARD GIOVANNOLI

[MS] Systematic and ecological notes on some fishes collected in the vicinity of Tortuguero, Caribbean coast of Costa Rica.

HILDEBRAND, SAMUEL F.

1946. A descriptive catalog of the shore fishes of Peru. *Bull. U. S. Natl. Mus.*, no. 189, xi + 530 pp., 95 figs.

MEEK, SETH E., and SAMUEL F. HILDEBRAND

1925. The marine fishes of Panama. Part II. *Field Mus. Nat. Hist.*, pub. no. 226; zool. ser., vol. 15: xv-xix + 331-707 pp., pls. xxv-lxxi.

SCHULTZ, LEONARD P.

1945. Three new sciaenid fishes of the genus Ophioscion from the Atlantic coasts of Central and South America. *Proc. U. S. Natl. Mus.*, 96 (3192): 123-137, figs. 5-8.

NOTES ON THE EGGS AND LARVAE OF *EURYCEA LUCIFUGA* RAFINESQUE

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Two recent papers (Hutchison, 1956, 1958) have contributed greatly to existing knowledge on the ecology and life history of the Cave Salamander, *Eurycea lucifuga* Rafinesque. However, the eggs have apparently not been previously found in nature, nor has the newly hatched larva been described. The notes presented herein are based mainly on a collection of eggs and larvae from Mushroom Cave in Meramec State Park, Franklin Co., Missouri, and on a small series of larvae from Reynolds Co., Missouri. This material has been placed in the University of Florida Collections (7 lots — UF 10001-10007). Although actual breeding was not observed, referral of these immature stages to *E. lucifuga* is believed justifiable. The related *E. longicauda* co-inhabits the Missouri range of *E. lucifuga,* but the two appear to occupy different habitats in the area under discussion,[1] and the eggs of *E. longicauda,* as described by Mohr (1943), are considerably larger.

The author is indebted to Dr. William J. Riemer for certain constructive criticism, and to Miss Esther Coogle for aid in preparing the accompanying figure.

Mushroom Cave is located in T40N, R2W, Sec. 13, as shown on the Meramec State Park quadrangle map. A map and description of the cave has been previously published (Bretz, 1956). Specimens were collected in a small stream, at a point approximately 800 feet from the largest of the three entrances, which are all situated on the side of a deciduously wooded bluff. The stream emerges from the cave during times of heavy rainfall, but throughout most of the year it disappears into its bed in the twilight region. Gradient is slight and depth probably averages less than a foot. The following temperatures were recorded near the head of the stream, January 20, 1957, water 11° C., air 12° C.; March 3, 1957, water 12° C., air 14° C.

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[1] In eastern Missouri, *E. lucifuga* and *E. longicauda longicauda* appear to have almost attained ecological isolation, seldom or never occurring in the same cave, but occasionally being found together outside of caves (Myers, 1958). In Virginia, they have often been found in the same caves (Hutchison, 1958), and have also been reported in association in caves of Dade Co., Georgia (Martof and Humphries, 1955). In Pennsylvania, where *E. lucifuga* is unknown, *E. longicauda* has been listed as common in some mine shafts, but apparently absent from limestone caves (Mohr, 1944). In western Missouri, *E. longicauda melanopleura* (as *Spelerpes stejnegeri*) has been reported from the same caves as *E. lucifuga* (*S. maculicaudus*) (Hurter, 1911). In Cherokee Co., Oklahoma, *melanopleura* has been recorded as common in caves, and *E. lucifuga* as occurring in wet moss and other vegetation at large springs (Bragg, 1955). Hutchison (1958) has discussed the possibility of competition between *E. l. longicauda* and *E. lucifuga* in Virginia, pointing out similarities in food habits and the fact that *E. longicauda* was found most abundantly in caves not frequented by *E. lucifuga.* Other references could probably be cited, but these sufficiently indicate the need for additional investigation concerning the interrelationships and habitat selection mechanisms of the two species.

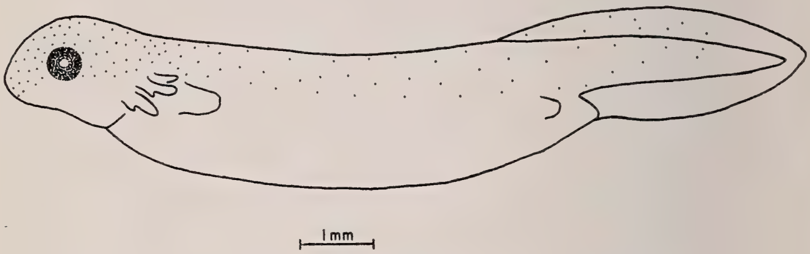

Figure 1. *Eurycea lucifuga* Rafinesque. Hatchling.

In addition to the larval salamanders, other amphibians collected in the cave were adult *Eurycea lucifuga, Plethodon glutinosus, P. cinereus,* and *Rana palustris.*

Eggs were found in various stages of development, from early cleavage to advanced embryos, on January 2, 1956. They were attached singly to the bottoms and sides of submerged rocks, several feet from the issuance of the stream out of the south wall. The individual egg was composed of an immaculate, white vitellus which was bound closely by the vitelline membrane, and surrounded by two translucent outer envelopes. The pedicel was apparently formed by a simple extension of the elastic outer envelope, and was not distinguishable after the egg had been removed from its point of attachment. Only eight eggs were discovered on this date and these rapidly deteriorated after preservation in weak formalin.

These eggs are not illustrated, as they agree well in appearance with the published account and illustrations of those obtained by pituitary gland implant (Barden and Kezer, 1944). The artificially induced eggs, however, were laid without attachment—probably a result of laboratory conditions. Barden and Kezer described the inner and outer envelopes as being fluid and jellylike respectively.

TABLE 1

EURYCEA LUCIFUGA: AVAILABLE INFORMATION ON EGG SIZE. ALL DIMENSIONS ARE DIAMETERS GIVEN IN MILLIMETERS. ALL EGGS ARE FROM FRANKLIN CO., MISSOURI UNLESS OTHERWISE INDICATED.

Date	Vitellus	Inner Envelope	Total Diameter	Remarks
January 2, 1956	3	——	3.8	All eggs of this date of natural laying.
	2.8	——	5	Two eggs.
	2.8	3.3	5	
	——	——	5	Four eggs in embryo stages.
June, 1952	——	——	0.6, 0.7, 1.0, 1.2, 1.6, 2.9	Approximate diameters of ovarian eggs from six females from Dade Co., Ga. (Martoff and Humphries, 1955)
July-August, 1955	——	——	2.83 (2.30 - 3.1)	Mean and range of means of 17 lots of ovarian eggs from Giles and Bland counties, Va. (Hutchison, 1956)
October 2, 1955	2.5	3	3.5	Two eggs forced from freshly killed specimen.
Fall, 1941	2.53 (2.41 - 2.61)	2.97 (2.70 - 3.30)	3.63 (3.52 - 3.75)	Means and ranges of seven eggs obtained by pituitary implant in specimen from Stone Co., Mo. (Barden and Kezer, 1944)

A few eggs in advanced embryo stages were also found in the cave on January 20, 1957. Well developed eggs were present in females from other Missouri localities on August 4, 1955 (Dent Co.), September 18, 1955 (Shannon Co.), and October 2, 1955 (Franklin Co.). One of the individuals, collected on October 2, lost two eggs when injected with preservative. These were complete with envelopes, and apparently nearly ready for oviposition.

The eggs of *Eurycea lucifuga* are apparently very similar in appearance, but not size, to those of *E. longicauda longicauda* (see Mohr, 1943, 1945). Mohr (1943) gave the following dimensions for *E. longicauda* eggs: vitellus 3 mm., inner envelope 5.5 mm., outer envelope 8 mm.

Four newly hatched larvae were found on January 2, 1956. One of these broke from the egg upon disturbance of its rock. The others were lying on the stream bed, and displayed frenzied but un-co-ordinated movement when touched. All four measured 11 mm. in total length on the day of collection. After several month's preservation in alcohol they measured 10 mm., of which approximately 8 mm. was body length. They were sparsely pigmented dorsally with grayish chromatophores on a whitish background; pigment was most concentrated on the head region. The gill and limb buds as well as the ventral surfaces were immaculate. Barr (1949) mentioned *"lucifuga"* larvae, 7 mm. in length, from a cave in Davidson Co., Tennessee, in January, but did not imply whether snout-vent or total length was measured, nor the condition of the larvae.

More advanced larvae were taken on several occasions in Mushroom Cave. Mean total length measurements and ranges of four lots follow: January 2, 1956, 15.5 mm. (15 specimens, 14-17 mm.); March 11, 1956, 17.5 mm. (13 specimens, 15-20 mm.); January 20, 1957, 17.9 mm. (13 specimens, 15-20 mm.); March 3, 1957, 18.8 mm. (12 specimens, 15-20 mm.). Only two larvae representing a larger size range were found (37 mm. total length on March 11, 1956, and 41 mm. on March 3, 1957).

A series of 10 larvae were collected in Reynolds Co., Missouri, on April 26, 1956. They were found in a small pool of drip water in the twilight zone of a small cave, and averaged 19.5 mm. total length (18-20 mm.).

Sinclair (1950) found larvae in pools at the mouths of caves in Tennessee, and reported specimens as large as 23 mm. on December

21, and as small as 14 mm. on February 4. Banta and McAtee (1906: 70) have speculated that the eggs are probably laid during early January in Indiana, but that small larvae found as late as March 20, might also indicate a later period of oviposition. Hutchison (1956) reported finding small larvae with an average length of 17.0 mm. in July, in Virginia.

CONCLUSIONS

Evidence indicates that *Eurycea lucifuga* breeds in either flowing or standing water, in the twilight region of caves and also in the zone of perpetual darkness. The breeding season is apparently lengthy, but it is not known how much of the total season is utilized by any given population, nor the extent of seasonal variation. Although available data are meager, the author would *tentatively* interpret them to indicate an egg deposition to hatching season commencing in October or November and ending in April or May.

Eggs found in nature measured 5 mm. in total diameter, and therefore can presumably be distinguished from the eggs of *Eurycea longicauda longicauda,* which are said to measure 8 mm.

Larvae measured 11 mm. at hatching and were quite helpless, falling to the stream bed upon breaking through the egg. This fact alone would probably prevent successful breeding in fast flowing or turbulent streams (especially those subject to flooding), and may account for the apparent absence of the species "in certain tunnel-like caves that had entrances drained by fairly large streams" (Myers, 1958).

LITERATURE CITED

BANTA, ARTHUR M., and WALDO L. McATEE

1906. The life history of the Cave Salamander, *Spelerpes maculicaudus* (Cope). *Proc. U.S. Natl. Mus.* 30: 67-83, figs. 1-3, pls. 8-10.

BARDEN, ROBERT B., and L. JAMES KEZER

1944. The eggs of certain Plethodontid salamanders obtained by pituitary gland implantation. *Copeia* 1944 (2): 115-118, pls. 1-2, 1 table.

BARR, THOMAS C., JR.

1949. A preliminary study of cave ecology, with special reference to Tennessee caverns. *Bull. Natl. Speleological Soc.* 11 : 55-59.

BRAGG, ARTHUR N.

1955. The amphibia of Cherokee County, Oklahoma. *Herpetologica* 11 (1) : 25-30.

BRETZ, J. HARLEN

1956. Caves of Missouri. *Missouri Div. Geol. Surv. and Water Resources (Reports, 2nd Series)* 39 : xxi, 1-490, figs. 1-168, frontispiece.

HURTER, JULIUS, SR.

1911. Herpetology of Missouri. *Trans. Acad. Sci. St. Louis* 20 : 59-274, pls. 18-24.

HUTCHISON, VICTOR H.

1956. Notes on the Plethodontid salamanders *Eurycea lucifuga* (Rafinesque) and *Eurycea longicauda longicauda* (Green). *Occ. Papers Natl. Speleological Soc.* 3 : 3-24, figs. 1-8, tables 1-2.

1958. The distribution and ecology of the Cave Salamander, *Eurycea lucifuga. Ecological Monographs* 28 (1) : 1-20, figs. 1-13, tables 1-10.

MARTOF, BERNARD, and ROBERT L. HUMPHRIES

1955. Observations on some amphibians from Georgia. *Copeia* 1955 (3) : 245-248.

MOHR, CHARLES E.

1943. The eggs of the Long-tailed Salamander, *Eurycea longicauda longicauda* (Green). *Proc. Pennsylvania Acad. Sci.* 17 : 86.

1944. A remarkable salamander migration. *Ibid.* 18 : 51-54, figs. 1-2.

1945. Long-tailed Salamanders. *Life Magazine.* Nov. 19 : 80-82, 9 figs.

MYERS, CHARLES W.

1958. Amphibia in Missouri caves. *Herpetologica* 14 (1) : 35-36.

SINCLAIR, RALPH MASON

1950. Notes on some salamanders from Tennessee. *Ibid.* 6 (2) : 49-51.

DOSIMETRY DETERMINATIONS OF GAMMA RAYS IN AN UNDERGROUND Co^{60} SOURCE[1]

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Man is exposed to many types of radiation—solar, therapeutic, diagnostic, atomic fall out, etc. He also comes in daily contact with potential chemical carcinogens—cigarettes, exhaust fumes, smog, coal tar products, food additives, and possibly many others. Recently it has been shown in this laboratory that a single, minute dose of the chemical, 9,10-dimethyl-1,2-benzanthracene (DMBA), can initiate latent tumor cells which can be developed into true tumors many months later by the co-carcinogenic action of croton oil (Klein, 1956). This suggests the possibility that an individual exposed to a subcarcinogenic amount of chemical may at some other time receive a dose of radiation, insufficient in itself to produce tumors, but capable of co-acting with the previous chemical exposure. To determine if an additive effect from these two stimuli exists, an experiment was planned in which the skin of mice is subjected to a subcarcinogenic dose of DMBA and later exposed to a subcarcinogenic level of gamma-radiation. As a source of gamma-rays, the Nuclear Engineering Department of the Engineering and Industrial Experiment Station and the Department of Chemistry of the College of Arts and Sciences of the University of Florida made available to us a Co^{60} source which had been installed recently on the University campus. Before this Co^{60} source could be employed for the type of biological experiment we desired to carry out, it was necessary to establish the gamma-ray intensity of this Co^{60} installation. Fricke and Morse (1929) were the first to suggest a chemical dosimetry method for measuring x-ray doses based on the oxidation of $FeSO_4$ in air-saturated 0.4M H_2SO_4. Many workers such as Miller (1950); Hardwick (1952); Lazo, Dewhurst and Burton (1954); and Weiss, Allen and Schwarz (1956), have modified and improved this method and it was selected as the most accurate and convenient procedure for the high energy gamma-ray measurements needed in the present study.

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[2] With the technical assistance of Mr. B. G. Crayton.

[3] Contribution from the Cancer Research Laboratory, J. Hillis Miller Health Center.

MATERIALS AND METHODS

The installation for the Co^{60} source consists of a room with its floor 10 feet below the surface of the ground. The Co^{60}, with an estimated strength of 835 curies, is near the bottom of a water-filled well approximately 12 feet further down. The cobalt is divided into 12 pencils, each made up of cobalt wafers 1 cm in diameter and of varying thickness (1 mm, 2 mm and 1 cm) with aluminum spacers. These cobalt pencils which are 5 9/16 inches long are placed in 12 tubes of ⅝ inch diameter arranged around a central port of 1 13/16 inch diameter. The center of each cobalt pencil is 9 inches from the bottom of the well. There are plugs of steel and lead placed below and above each cobalt pencil. In order from the bottom there are: a steel plug 3 inches long, a lead plug 3⅛ inches long, the cobalt pencil 5 9/16 inches long, and a lead plug 3⅛ inches long. In the center and surrounding this source-cluster there are 11 vertical ports which run to a depth of 11 feet and 10 inches from the working platform. The largest port, 4 inches in diameter, was selected for our biological experiments: its center is 3¾ inches from the center of the source-cluster. Intensity measurements of the gamma rays were made in this port, employing the chemical dosimetry method based on the oxidation of ferrous ions.

Ferrous ammonium sulfate (2×10^{-3} M) was made up in 0.4 M H_2SO_4. Since it was suggested by Dewhurst (1951) that addition of chloride ions would inhibit the oxidation of ferrous ions by certain organic impurities, chemically pure NaCl (10^{-3} M) was added. The water for all solutions was prepared by triple distillation from acid and alkaline permanganate.

For each radiation exposure a 5 ml aliquot of the ferrous solution in a 25 ml, ground glass stoppered, test tube was employed. The tubes were irradiated individually in a copper screen cup which was lowered to the desired depth by a steel cable connected to a hand-operated windlass. Each sample was shaken well to aërate the solution before it was lowered into the port. The time required for lowering and raising the tube, as well as the exposure time at the desired depth, was measured with an electric stop watch.

The amount of ferric ion formed was determined spectrophotometrically in a Beckman Model DU Spectrophotometer with ultraviolet attachment. Optical densities were recorded at 3040 Å, the wave length at which ferric ions have maximum absorption (Hochanadel, 1957). Ferrous ions and H_2O_2 do not interfere (Hochanadel and Ghormley, 1953). Spectrophotometric measurements were carried out at 25° C. Samples were read at 2 hours following irradiation and were reread at 15 hours. No change in optical density was noted over this time period. The non-irradiated ferrous solution served as a blank.

The dose in roentgens (r) was calculated from the optical density measurements using the following formula (Hochanadel, 1957):

$$\text{dose rate in ev/g} = \frac{(D_{\text{sample}} - D_{\text{blank}})\, 6.023 \times 10^{25}}{l \times e \times G \times d \times 10^{3}}$$

D = optical density
l = optical path in cm
e = molar extinction coefficient
G = 100 ev yield
d = density

The yield was taken as 15.6 ± 0.3
$e = 2240$ at 25° C. (+ 0.7% / C°)
$l = 1$ cm
dose rate in ev / g $= 1.683 \times 10^{18} (D_s - D_b)_{3040}$
roentgens $= 6.06 \times 10^{13}$ ev/g of solution
roentgens $= 2.78 \times 10^{4} (D_s - D_b)_{3040}$

RESULTS AND DISCUSSION

To verify the correct operation of the spectrophotometer, 5 ml samples of the ferrous ammonium sulfate solution were oxidized with known quantities of ceric ammonium sulfate (2×10^{-3}) as shown in Table 1, column 4. Each sample was diluted to a total volume

TABLE 1

Sample No.	Ferrous solution (moles in 5 mls)	Ceric solution added (ml)	Ceric solution added (moles)	Ferric ion formed (moles)	O.D. at 3040 Å
1	0.00001	0.5	0.000001	0.000001	0.229
2	0.00001	1.0	0.000002	0.000002	0.411
3	0.00001	2.0	0.000004	0.000004	0.825

of 10 ml and was read at 3040 Å. The readings are shown in Table 1, column 6, and the optical density values are in good agreement with the molar concentrations, column 5. To establish the fact that ferric ion instead of unreacted ceric ion was measured, the optical density was determined for Sample No. 1 over a series of wavelengths from 3000 to 3300 Å. A maximum absorption at 3040 Å was found. Ceric ion has a maximum at 3200 Å.

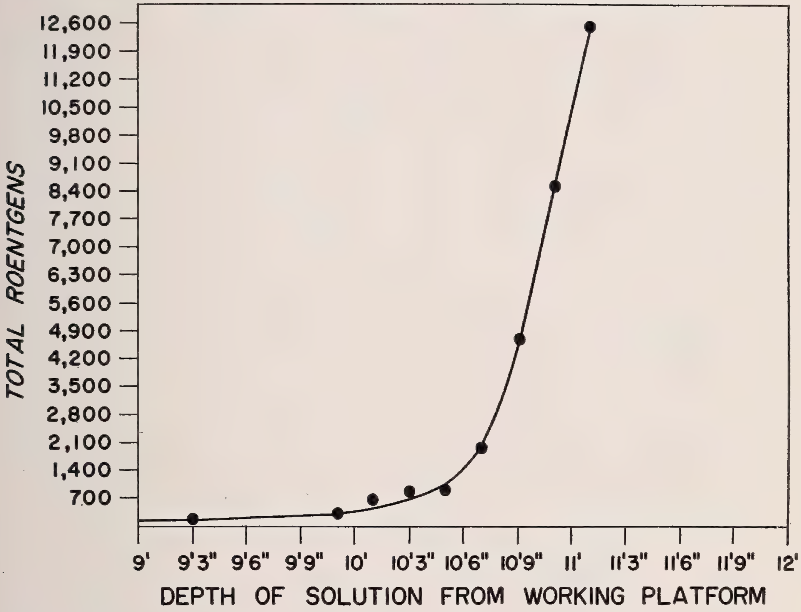
The first measurements in the 4-inch port of the Co^{60} installation were made at a depth corresponding to the center of the cobalt pencils. Since this point is 9 inches from the bottom of the port, the tubes containing the solution were lowered to a depth of 11 feet 1 inch from the working platform. Samples were irradiated at exposure times from 1 to 30 minutes. The total dose in roentgens was determined for each irradiation time (Table 2, column 4). The dose rate values (Table 2, column 5) were consistent (average, 765r/min) only when the total dose was greater than 8,0000r. For the shorter time intervals, where the time for lowering and raising the solution constituted a larger percentage of the total time, the dose rate was recalculated using the total time the tube was in the port (Table 2, column 5, figures in parentheses). These values are closer to the average dose rate calculated for times of exposure 5 minutes or greater.

TABLE 2

Time for lowering and raising tube (sec)	Time of exposure at 11′ 1″ depth (min)	O. D.	Total dose (r)	Dose rate (r/min)
30	1	0.046	1,278	1,278 (852)*
30	2	0.066	1,834	917 (734)*
20	5	0.180	5,003	1,001 (939)*
17	10	0.302	8,395	840
17	15	0.396	11,010	734
17	20	0.599	15,260	763
17	25	0.699	19,430	777
17	30	0.770	21,400	713

* Value in parenthesis indicates dose rate when correction is made for the time required to lower and raise the tube.

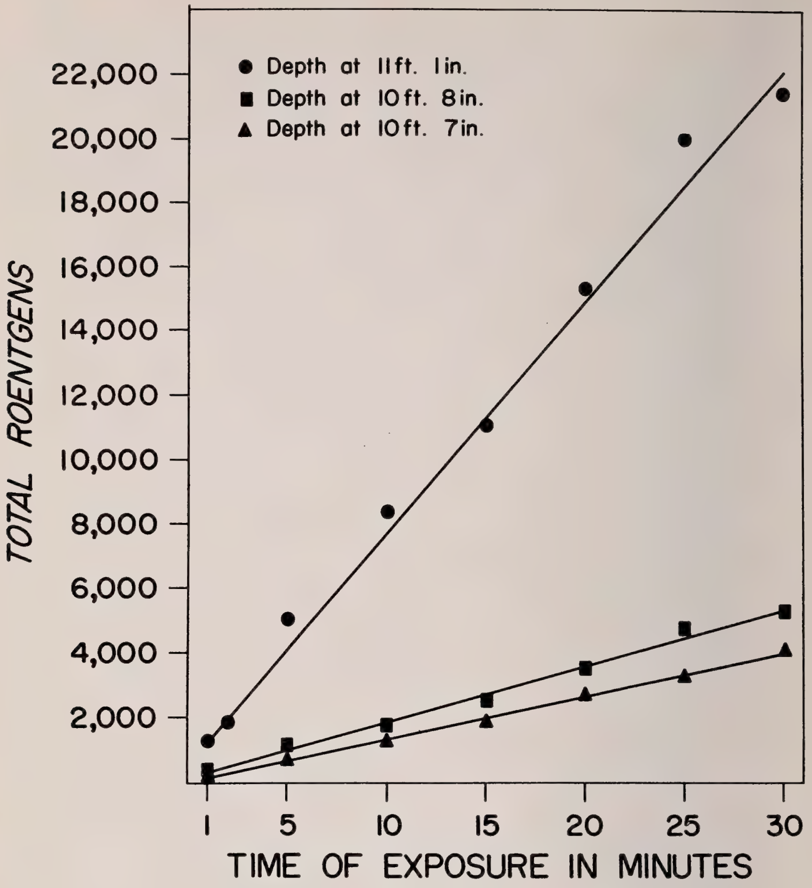
Keeping the exposure time constant at 15 minutes and the time to lower and raise the tube constant at a total of 15 seconds, total roentgen doses were next determined at different depths in the 4-inch port. The results are shown in Figure 1. It is evident that the intensity of the radiation decreases as the distance between the center of the source and the tube containing the solution increases. There is a great cut-off of energy at a depth of 10 feet 5 inches.



Dosimetry determinations were then made for three depths. The time for lowering and raising the solution totaled 15 seconds for each exposure. The ranges of total roentgens from 1 to 30 minutes exposure time were: 1278 — 21,400r at 11 feet 1 inch, 333.6 — 5282r at 10 feet 8 inches, and 166.8 — 4031r at 10 feet 7 inches. These values are plotted in Figure 2. This gives a chart from which the time and depth of exposure can be determined for a desired total roentgen dose.

SUMMARY

To extend the usefulness of the Co^{60} source to biological experiments, gamma ray dosimetry measurements were made in the 4-inch port which is suitable for the irradiation of small experimental animals. Data is provided which permits accurate administration of radiation dosages.



LITERATURE CITED

DEWHURST, H. A.

1951. Effect of organic substances on the γ-ray oxidation of $FeSO_4$. *J. Chem. Phys.*, 19 : 1329.

FRICKE, H., and MORSE, S.

1929. The action of x-rays on $FeSO_4$ solution. *Phil. Mag.*, 7 : 129.

HARDWICK, T. J.

1952. Oxidation of $FeSO_4$ solutions by x-ray — the absolute yield. *Can. J. Chem.*, 30 : 17.

HOCHANADEL, C. J.

1957. Elements of radiation dosimetry for chemists. *O. R. I. N. S.*, March 26, 1957.

HOCHANADEL, C. J., and GHORMLEY, J. A.

1953. A calorimetric calibration of gamma-ray actinometers. *J. Chem. Phys.,* 21 : 880.

KLEIN, M.

1956. Induction of skin tumors in the mouse with minute doses of 9,10-dimethyl-1,2-benzanthracene alone or with croton oil. *Cancer Research,* 16: 123.

LAZO, R. M., DEWHURST, H. A., and BURTON, M.

1954. The ferrous sulfate radiation dosimeter: A calorimetric calibration with γ-rays. *J. Chem. Phys.,* 22 : 1370.

MILLER, N.

1950. Quantitative studies of radiation-induced reactions in aqueous solutions. I. Oxidation of ferrous sulfate by x- and γ-radiation. *J. Chem. Phys.,* 18 : 79.

WEISS, J., ALLEN, A. O., and SCHWARZ, H. A.

1956. Use of the Fricke ferrous sulfate dosimeter for γ-ray doses in the range 4 to 40 kr. *International Conference of Peaceful Uses of Atomic Energy,* 14 : 179.

NOTES ON THE BARRED PATTERN IN THE SHEEPSHEADS, *ARCHOSARGUS PROBATOCEPHALUS* AND *A. OVICEPS*

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In his original description of *Archosargus oviceps,* Ginsburg (1952) discusses the variation in color pattern of this form and its near relative, *A. probatocephalus* (Walbaum). The only substantial character he found (with which I concur) to distinguish the two forms is the number of dark bars on the side. Not counting the incomplete head bar, *A. oviceps* has five (Figure 1A), and *A. probatocephalus* has six (Figure 1B).

Ginsburg suggested that the geographic dividing line between the forms lies in the Gulf of Mexico in the vicinity of the Florida-Alabama line (*A. oviceps* to the west and *A. probatocephalus* to the east). The specimens I have examined from Destin, Florida, some 70 miles east of the state line, are primarily 5-barred, and those from Cedar Key, Florida, are mostly 6-barred. Joseph and Yerger (1956: 136), in anticipation of the placing of Ginsburg's *A. oviceps* in synonomy (personal conversation with Yerger in March, 1958), listed *A. probatocephalus* from Alligator Harbor, Franklin County, Florida, although their specimen was of the 5-barred type. Alligator Harbor lies about 175 shoreline miles east of Destin, and about 115 shoreline miles northwest of Cedar Key. Thus the break between the two primary color variants must lie somewhere between Cedar Key and Alligator Harbor.

Analyzing the two forms, Ginsburg found that of 269 specimens of *A. probatocephalus* he examined, 24 had 6 bars on one side and 5 on the other and 14 had 5 bars on both sides. Since he found these non-6-barred patterns only on specimens 74 mm. (presumably standard length) or smaller, and as all specimens he examined which were 92 mm. or larger had 6 bars, he felt that " . . . an obvious and plausible explanation . . . " for the non-6-barred condition in *A. probatocephalus* " . . . is linked with a lethal factor which results in the failure of such variants to reach some size, much less to reach adulthood." He thus postulated a " . . . physiological barrier . . . " as one of the isolating factors between the two forms. Of 78 specimens he examined of *A. oviceps,* two (14 and 35 mm.) had the asymetrical pattern—none had 6 bars on both sides. He also suggested that the physiological barrier was operating here and it must be presumed that a 6-barred individual from the range of *A. oviceps* would also be considered a "variant" and subject to the barrier. Although the possibility of sympatric species, or of allopatric species exhibiting parallelism in all age groups (see below), cannot be discounted, Ginsburg obviously did not subscribe to these possibilities and considered his species a member of an allopatric species-pair, neither of which exhibits parallelism in the adult or sub-adult stages.

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Ginsburg also discussed a geological barrier possibly related to past geologic history. However, it is not the aim of this paper to discuss this, nor should it be considered a revision of the group—though a broad nomenclatorial postulation is presented below. Rather, its purpose is to report specimens which would fall into Ginsburg's classification of "variants" and yet which have reached maturity, or at least adult or sub-adult size. Some of the variations reported below are much more bizzare than those discussed by Ginsburg, and still others undoubtedly exist. I agree with him that the particular banded pattern is almost surely constant once established in an individual.

The bar-pattern-variants may conveniently be divided into two groups—those which are known from the range of 6-barred *A. probatocephalus* and those from the range of 5-barred *A. oviceps.*

In the first category the only variants which I have seen are ones with 5 bars on both sides (Figure 1A). In the 5-barred condition the bars are somewhat wider than those found on 6-barred fishes.

The first of these (University of Florida Collections 2269), 272 mm. in standard length, was collected on January 10, 1954, at Cedar Key, Levy County, Florida. The second (UF 2281), 221 mm. in standard length, was taken at Blind Pass, between Sanibel and Captiva islands, Lee County, Florida, on February 3, 1954. This locality is about 240 shoreline miles south of Cedar Key. The specimen was a fully mature, running ripe, male. Dr. Victor G. Springer, of the Florida State Board of Conservation, writes that he has noted three variant specimens from the range of the 6-barred *A. probatocephalus.* All are from or off the Tampa Bay region of the west coast of peninsular Florida about midway between Cedar Keys and Blind Pass. These records are summarized as follows: (1) February 14, 1958, one, with a 6-5 pattern, 230 mm. in length, from about 8 miles offshore between Indian Rocks Beach and Clearwater. (2) February 24, 1958, one, with a 5-5 pattern, 80 mm. in length, from Cross Bayou Canal, Pinellas County. (3) February 24, 1958, one, with a 5-5 pattern, 81 mm. long, from the southern part of Boca Ciega Bay, Pinellas County. Dr. Springer wrote that all were taken in company with 6-6 barred individuals. Mr. Thomas R. Hellier, Jr. (who was searching for such variants for me), told me that he observed a 5-barred individual, approximately 225 mm. in standard length, in a commercial fish house at Jensen Beach (near Ft. Pierce), Martin County, lower Atlantic coast of Florida. The fish had been taken locally. I photographed another individual with 5 bars in the tanks of Marine Studios, Marineland, Florida, in September, 1954. I was told by the curator, Mr. F. G. Wood, that this fish, estimated to be about 125 mm. in standard length, was caught in the vicinity of St. Augustine, St. Johns County, Florida.

The variants observed from within the range of *A. oviceps* are all from Destin, Okaloosa County, Florida—near the eastern end of the range of this form. All of the fishes noted below were living in the tanks of Florida's Gulfarium at nearby Ft. Walton Beach. Lengths are estimates, but all fish were full adult or sub-adult in size. I have photographs of all of these (from which the accompanying figures were taken), but the officials of the Gulfarium were understandably loath to part with their hard-caught specimens—even for scientific purposes. I first observed all but the one illustrated as Figure 1 F on July 16, 1956. All had been collected from the same spot (under the U. S. Highway 98 bridge over East Pass) and on such closely spaced dates that a single local resident population was presumed to have been sampled. It is therefore of special interest to note that all of the bar patterns illustrated in Figures 1 A to 1 E were taken from precisely the same local population. These captive individuals were still living in July, 1957, when the oddly marked individual illustrated in Figure 1 F, taken from the same locality, was first observed.

Individuals with six bars on both sides (Figure 1 B) were not infrequently encountered at the Gulfarium. I observed 6, all longer than 350 mm. standard length. Hildebrand (1955: 211) also found this variation in specimens he examined at Port Isabel, Texas, about 940 shoreline miles west of Destin. In addition, he noted

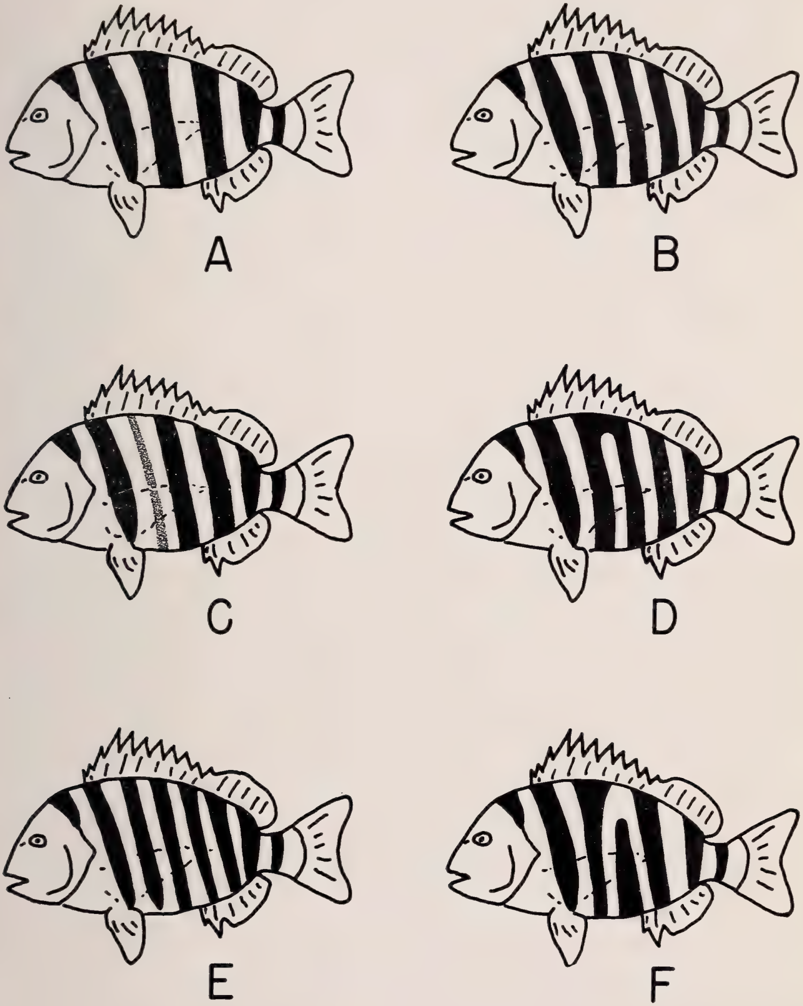

Figure 1. Semi-diagramatic representation of some variations in bar pattern in the black-barred sheepsheads, *Archosargus probatocephalus* (Walbaum) and *A. oviceps* Ginsburg. See text for explanation of figure. (General body outline after Smith, 1907: Plate 14).

them south of Texas—on the Mexican coast. He listed a small locally-caught 6-barred individual in the collection of the Institute of Marine Science of the University of Texas, at Port Aransas, approximately 815 shoreline miles west of Destin. I have seen this specimen and can confirm his bar count. Another Gulfarium specimen, approximately 450 mm. in standard length, had 6 normally-sized and placed bars on the left side (Figure 1 B). The pattern on the right side also consisted of 6 bars, but the second full bar was much narrower (half the width of the others) and less intense (Figure 1 C). Another individual, approximately 350 mm. in standard length, had 6 bars on each side, but the second and third full bars on the right side were joined dorsally by an equally intense cross-bar (Figure 1 D). Still another large fish, about 450 mm. in standard length, had 6 bars on its left side and 7 on the right (Figure 1 E). With regard to this variation it is thought-provoking to note that Smith (1907 :301), in describing the color of *A. probatocephalus,* in North Carolina, stated that the body has "6 to 8 broad, black, nearly vertical bands." Even counting the incomplete head band, thus giving a count of 7 for the nominal form *A. probatocephalus,* the "8" would infer that he observed at least one 7-barred specimen, in addition to 5-barred specimens inferred by his count of "6" (counting bars as described earlier in this paper). The last variant observed at the Gulfarium is one with 6 bars on the right side, and the pattern illustrated in Figure 1 F on the left. This fish was about 275 mm. in standard length.

Hildebrand (1955: 211) notes that he found a specimen with the asymetrical (6-5) bar pattern from the Campeche banks off the west coast of Yucatan, Mexico.

In black-barred forms of *Archosargus,* one bar is located near the base of the caudal fin and two others are positioned below the origin and end of the dorsal fin. These 3 and the incomplete bar on the head apparently are stable in position (Figure 1). The bars between those below the origin and end of the dorsal fin are the ones that have been reported to produce the variation (Figure 1).

It becomes evident that the character of color pattern in the black-barred sheepsheads can be unstable, whether genetically or ecologically influenced, and it seems quite likely that thorough analysis of large series of sheepsheads may prove *A. oviceps* synonymous with *A. probatocephalus,* as suggested by Hildebrand (1955:

212); or more likely, since the two nominal forms do exhibit the reasonably constant single character of bar number, of subspecific rank—at least for the sake of nomenclatorial convenience. *A. aries* (Valenciennes)[2], a South and Central American form apparently distinguished only by having narrower bars (6) than *A. probatocephalus* (Ginsburg, 1952: 96) and teeth, possibly also falls into this pattern complex, as suggested by Eigenmann and Hughes (1888: 69).

In addition to the above-described variations in bar pattern, the following aberrantly-colored specimen of *A. probatocephalus* has been loaned to me by Dr. Springer. At his request, this specimen will be deposited in the fish collection of the United States National Museum.

The fish is 218 mm. in standard length and to all intents might be superficially called an albino. However, since there is some melanophoric pattern still evident in the preserved fish, and since Dr. Springer wrote that as a fresh specimen "there was much color present as carotenoids," this individual might be more properly termed a golden variant. Hubbs and Springer (1957: 308) have reported such a color variation in *Gambusia hurtadoi* Hubbs and Springer from fresh water in Mexico. Dr. Springer has kindly allowed me to include here his color notes taken from the sheepshead when fresh. It was collected by T. Schaum on November 15, 1957, in Tampa Bay, Florida (more precisely, south of Bunce's Bridge—second bridge south of St. Petersburg on the Sunshine Causeway, U. S. highway 19). Dr. Springer wrote: "Life coloration. Overall body color bright golden yellow with scale margins pinkish. Spines of dorsal pinkish, posterior dorsal yellow with base pinkish. Caudal: dusky on center rays, upper and lower rays pinkish orange; posterior margin light yellow. Anal spines pinkish as is anal base; rays yellow. Pelvic: pink-yellow; pectoral same as pelvic, but with a black blotch at bases of upper rays and in axil. A poorly defined humeral spot on one side. Lips pink; forehead pink and gold; breast light yellow, belly pink; iris golden." The pectoral blotch and the humeral spot are present in normally pigmented black-barred sheepsheads, but are obscured by the black bars. This golden specimen has very light traces of 6 complete bars, in addition to a faint head bar. In addition to this specimen, Dr. Springer stated that he had had reports of two additional "golden" color-variants, but that he had been unable to see them and so listed them only tentatively.

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[2] In using the single author name I follow Bailey (1951: 249).

In addition to acknowledging the cooperation received from those persons cited within the body of the text, I wish to thank Messrs. William W. Anderson, Frederick H. Berry, and Jack W. Gehringer, all of the United States Fish and Wildlife Service at Brunswick, for many helpful comments regarding the present paper. An earlier version was examined by Drs. John C. Briggs, Archie Carr, and J. C. Dickinson, Jr., all of the University of Florida, and their criticisms were most helpful in developing the final manuscript.

Literature Cited

BAILEY, REEVE M.

1951. The authorship of names proposed in Cuvier and Valenciennes' "Histoire Naturelle des Poissons." *Copeia,* 1951(3): 249-251.

EIGENMANN, CARL H., and ELIZABETH G. HUGHES

1888. A review of the North American species of the genera Lagodon, Archosargus, and Diplodus. *Proc. U. S. Nat. Mus.* 10 (for 1887): 65-74.

GINSBURG, ISAAC

1952. Eight new fishes from the Gulf coast of the United States, with two new genera and notes on geographic distribution. *Jour. Washington Acad. Sci.,* 42(3) : 84-101.

HILDEBRAND, HENRY H.

1955. A study of the fauna of the pink shrimp (*Penaeus duorarum* Burkenroad) grounds in the Gulf of Campeche. *Publ. Inst. Mar. Sci. Univ. Texas,* 4(1) : 169-232.

HUBBS, CLARK, and VICTOR G. SPRINGER

1957. A revision of the *Gambusia nobilis* species group, with descriptions of three new species, and notes on their variation, ecology, and evolution. *Texas Jour. Sci.,* 9(3) : 279-327.

JOSEPH, EDWIN B., and RALPH W. YERGER

1956. The fishes of Alligator Harbor, Florida, with notes on their natural history. *Florida State Univ. Studies, No.* 22, *Papers from the Oceanogr. Inst., No.* 2, pp. 111-156.

SMITH, HUGH M.

1907. The fishes of North Carolina. Raleigh, North Carolina Geological and Economic Survey, II: xi + 453 pp.

NOTES ON THE DEVELOPMENT OF *ANADYOMENE STELLATA* (WULF.) C.AG.

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This marine green algal genus has enjoyed a somewhat unsettled taxonomic position since its erection by Lamouroux in 1816. Harvey (1858) placed the species in the Valoniaceae mainly because he observed that the frond construction is a series of vesicated cells. Collins (1909) placed the species in the Cladophoraceae. His observation of the chromatophore was that it is either broken into many small portions or is net-form with many pyrenoids. Børgesen (1913) placed the plant in the Valoniaceae, most probably also on the basis of the vesicular appearance of the flabellar cells. He noted, however, that cellular division typical of the Valoniaceae was never seen; he postulated that it probably took place in a manner similar to that of the Cladophoraceae. His observations on the cellular chromatophore were quite critical. Instead of having a net-form single chromatophore, Børgesen noted that the cell contained many chromatophores which were small polygonal plates with prolonged edges forming a network and each containing a pyrenoid. Børgesen (1925) erected the family Anadyomenaceae for the species and for the allied genus *Microdictyon,* because it seemed a more natural grouping to him. *Anadyomene* and *Microdictyon* are the only two genera of the family which form a flat leaf-life thallus. Taylor (1928) placed the species in the Valoniaceae. Fritsch (1948) stated that the genus probably belongs to the Valoniaceae, but its affinities must remain unsettled until the detailed development is studied.

Abundant material of *Anadyomene stellata,* collected at Tarpon Springs, Florida, on January 16, 1958, was in all stages of development. This material was epiphytic on *Digenia simplex.* Opportunity was thus afforded to study the development of the plant.

A characteristic of the Valoniaceae is that the frond originates as a vesicular or clavate cell. As can be seen in Figs. 1-5, this is definitely not the case with *Anadyomene stellata.* As the figures reveal the first structure formed is a repent filament. From this swellings occur (Fig. 3) which result in a cell which varies from clavate (Figs. 1 and 4) to long cylindrical (Fig. 2). Harvey (1858) stated that the frond develops from a basal mat of filaments which emit erect branches. This type of development agrees with that of the Cladophoraceae. The original repent filament is attached to the substrate by coralliform discs and rhizoids. The cells of the repent filament contain protoplasmic material rich in chloroplasts. These chloroplasts are described above and are characteristic of the Valoniaceae. As a swelling arises from this filament the protoplasmic material of the cell extends into the swelling. As cell division occurs the cellular protoplasm is also divided. As can be seen in the figures, the cells divided from the primary erect cell are all clavate or vesicular in appearance.

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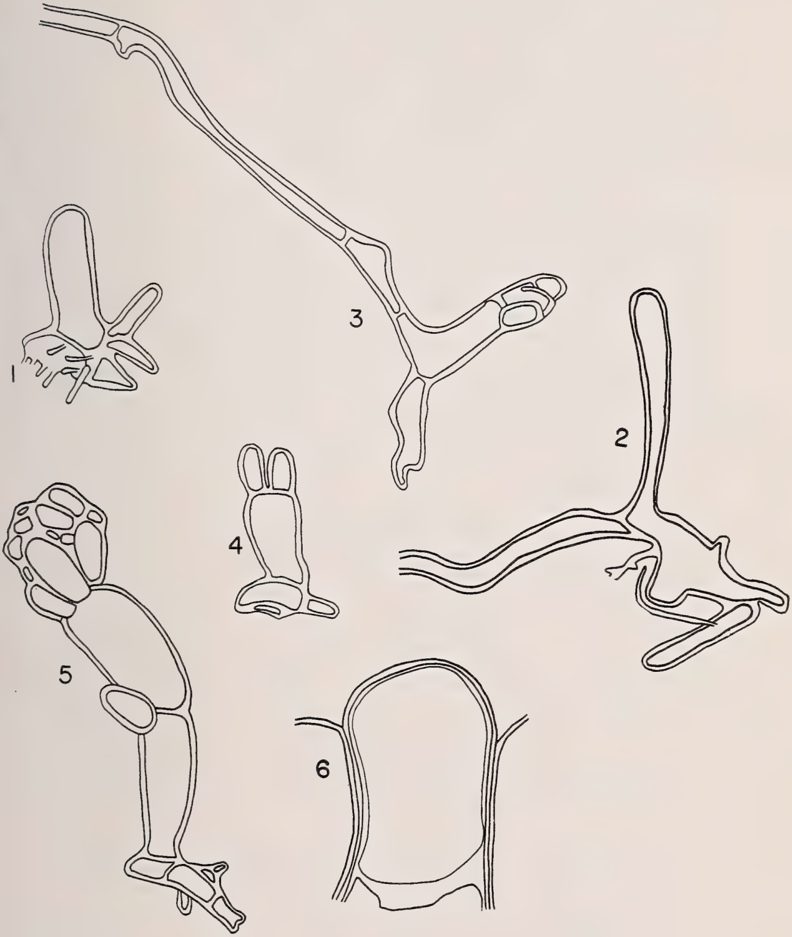
[1] Contribution No. 11 from the Fla. State Board of Conservation Marine Laboratory, St. Petersburg, Florida.

To resolve the family affinities it was felt that the method of cell division would have to be established. Børgesen (1913) could not find cell division but postulated that it would be similar to that in the Cladophoraceae. All the cells of the plant possess very thick laminated walls as do most forms in the Cladophoraceae. Børgesen's conclusion concerning the cell division and subsequent wall formation is most probably based on this observation. The cell division characteristic of the Valoniaceae was termed segregative division by Børgesen (1913). In this process the contents contract and undergo division into a number of multinucleate rounded masses, each of which secrete membranes independent of that of the parent cell and then enlarge so that they become pressed against one another. Enlargement of the whole thallus may thus take place.

On the outer frond margin of one of the young plants a cell was observed with a wall delimiting two masses of cellular protoplasm. As can be seen in Fig. 6, this wall is very thin, sac-like, and independent from that of the parent wall. Also, the free edge of the protoplasm appears very jagged, as if the two masses had been pinched off from each other. The membrane could then have been secreted by the pinched off protoplasm and then expanded against the parent cell wall as the protoplasmic mass enlarged. No protoplasmic connections between the two masses were seen. I interpret this as affording evidence of segregative cell division in this species. I cannot explain the filamentous nature of the repent filament base if the cells arise by segregative cell division, but this process, how-



Figures 1-5. Various developmental aspects of extremely young *Anadyomene stellata* plants. Note swelling on repent filament in Fig. 3, representing beginning of first upright cell. Fig. 1—520X, Fig. 2—540X, Fig. 3—525X, Fig. 4—500X, Fig. 5—512X.

Figure 6. One cell in frond displaying the sac-like membrane characteristic of segregative division. 837X.

ever, would explain the vesicular appearance of the cells of the frond. It would not, however, explain the very thick laminated cell wall surrounding each cell of the plant. In addition in place of simultaneous division into a number of protoplasmic masses, there seems to be a pinching off of only one mass at a time, thus producing a thallus with a flat plane.

The plants of this species originate and begin growth in the manner of the Cladophoraceae. Division of the cells of the frond appear to take place as in the Valoniaceae. The chromatophore arrangement is that of the Valoniaceae. The cells of the stipe in the mature plant are all long cylindrical. As can be seen in most of the figures, most immature stipe cells are short cylindrical but lengthen as the plant matures. Many times rhizines grow out towards the plant base from the lowermost portion of the cell ribs. These entwine around the stipe and add to its strength. They also form coralliform discs and rhizoids when they reach the substrate and thus aid in anchorage of the plant. The cells of the rhizines are long cylindrical. At the present time the author does not wish to remove *Anadyomene stellata* from the Valoniaceae, however, this family may not truly serve its most natural systematic position.

LITERATURE CITED

BØRGESEN, F.
1913. The marine algae of the Danish West Indies, I: Chlorophyceae. *Dansk Bot. Arkiv.*

BØRGESEN, F.
1925. Marine algae from the Canary Islands. I: Chlorophyceae. Kgl. *Danske Vidensk. Selsk., Biol. Meddl.* 5(3).

COLLINS, F. S.
1909. The green algae of North America. *Tufts Coll. Stud.* 2(3).

FRITSCH, F. E.
1948. The Structure and Reproduction of the Algae. Vol. 1. Cambridge.

HARVEY, W. H.
1858. Nereis Boreali Americana. *Smithsonian Contrib. to Knowledge.* Pt. 3, Chlorospermae and Suppl.

TAYLOR, W. R.
1928. The marine algae of Florida, with special reference to the Dry Tortugas. *Pap. from the Tortugas Laboratory of the Carn. Inst. Wash.* 25. Publ. 379.

LITHOLOGIC FEATURES OF MIOCENE SEDIMENTS EXPOSED IN THE DEVIL'S MILL HOPPER, FLORIDA[1]

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Abstract

Lithologic characteristics of Miocene sediments exposed in the Devil's Mill Hopper, a large sink hole located in north-central peninsular Florida, are briefly discussed. These features include silicified clay, the gradation of clay into lenses and irregular masses of limestone and sandstone, the possible dolomitization of clay, intraformational breccias and conglomerates, and a probable phosphate reaction zone that appears to represent hard-rock type phosphate in the process of being formed.

Introduction

Approximately 120 feet of marine Hawthorne sediments (Miocene in age) are exposed at the Devil's Mill Hopper, a large sink hole located approximately 6 miles northwest of Gainesville in north-central peninsular Florida. The lithologic characteristics of these materials are quite unusual and raise a number of interesting problems. The purpose of this paper is more to indicate some of these unusual features than to give a complete and adequate explanation for their origin.

Cooke measured a section at the sink in 1913 (Cooke, 1945: 147). Because of the many intervals of covered slope indicated by Cooke, the following section (modified from Pirkle, 1956: 215) was measured after removing the slumped materials. It should be emphasized that because of the irregularities of the sediments, sections made at different places around the sink would not completely correspond, although they would be similar.

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[1] Much of the material presented here was included in the introductory part of a dissertation prepared under the direction of the late Dr. John L. Rich and Dr. William F. Jenks. The dissertation was submitted to the University of Cincinnati to fulfill partial requirements for the degree of Doctor of Philosophy.

Section at Devil's Mill Hopper

Section 15, T. 9 S., R. 19 E., Alachua County, Florida

11.	Sand. Loose, gray to white	3′
Hawthorne		
10.	Abundant pebbles and grains of phosphorite in a matrix of sand and clay. See Table I for analyses of this phosphate	25′
9.	Sandy limestone or calcareous sandstone. Cream to white, containing in places abundant molds and casts of marine pelecypods and gastropods. Locally, phosphate particles are common	30′
8.	Dolomitic limestone. Whitish to gray, dense. At some places around the sink a grayish to blue-gray sandy clay occurs between this dense dolomitic limestone and the sandy limestone or calcareous sandstone of bed 9	3′
7.	Mainly blocky clay. Toward top of bed, in places, a grayish to blue-gray sandy clay containing occasional impressions and silicified shells of marine mollusks	30′
6.	Limestone. Similar to bed 4	2½′
5.	Largely clay. Greenish gray to gray, similar to bed 3	4½′
4.	Sandy limestone. Common calcite fossil shells, angular blocks and rounded pebbles of clay, and phosphate pebbles and grains	1½′
3.	Blocky clay. Greenish gray to gray, a few phosphate pebbles and rare impressions of marine fossils	13′
2.	Dolomitic limestone. Dense, dark colored, with stringers of quartz sand. Grades down into a loosely cemented, calcareous sandstone. Both dense limestone and sandstone contain blocks of clay. Locally, this bed is highly silicified and rests directly on Ocala limestone. In such cases, the upper surface of the Ocala is silicified	2½′
1.	Sand. White to gray, loose to slightly cemented. A few brown phosphate pebbles and grains	3′
	Total depth	123′

Ocala limestone (Eocene) occurs just beneath the bottom of the sink. In one of the open solution channels leading downward from the bottom of the Mill Hopper, Ocala limestone was collected in place by H. K. Brooks.

TABLE 1 (Pirkle, 1957)

Analyses of a 35 pound sample collected from bed 10 at the Devil's Mill Hopper, Alachua County.

Data available through the courtesy of the American Metal Company, Limited.

Chemical analyses run by Thornton and Company of Tampa, Florida.

Weight of Matrix (wet)	35	lbs.
Weight of —½ plus 14 phosphate (dry)	8.62	lbs.

	Wet screening— —½ plus 14	Flotation— —14 plus 150			
		Concentrate	Tailings	Heads	Slime
Tons per Acre Foot	543	182	666	848	
Phosphoric Acid (P_2O_5)	28.86%	31.06%	3.20%	9.19%	7.87%
B. P. L.	58.70%	67.86%	7.00%	20.07%	17.19%
Iron and Alum. Oxide	5.10%	4.72%			
Insoluble	14.62%	4.00%	88.08%	70.02%	

FLOTATION FEED

Ratio: Dry feed to dry recovered phosphate, flotation —14 plus 150 4.66 to 1.

Composition:	Dry Concentrate	21.46%
	Dry Tails	78.54%

FEATURES OF BEDS 3, 5, 7 AND 8

General Discussion of Clay

The clay in beds 3, 5 and 7 is very fine-grained and even-textured. The dominant clay mineral, identified by differential thermal analysis, is montmorillonite. It is of fuller's earth type (Cooke, 1945: 147). Several writers have indicated the possibility that such fuller's earth clay as that found in the Devil's Mill Hopper might be volcanic in origin. Mansfield (1940: 9) stated that "Recent field study by H. X. Bay, with laboratory investigations by P. G. Nutting, has brought to light evidence which may indicate that the major occurrences of naturally active clay in the Southeastern

States have been derived directly from volcanic ash or indirectly from the same source through bentonites." C. S. Ross in describing similar clay collected from Citrus County, Florida, by R. O. Vernon (Vernon, 1951: 187) indicated that the clay had physical properties which suggested that it might be bentonitic. A thin section of fuller's earth clay collected in Marion County, Florida, showed possible structures of glass shard relicts (Grim, 1933: 358).

Because no definite glass shards or relict structures of such shards have been found, a volcanic origin for the fuller's earth type clay at the Mill Hopper can not be proved. Nevertheless, it must be admitted that certain features observed at the sink would be more easily explained if the clay had such an origin. For example, the zone of silicification at the bottom of the clay sequence in bed 2, the silicified upper surface of the underlying Ocala limestone, and the occurrence of occasional silicified fossil shells in beds 3, 5 and 7 as well as the silicification of clay within those beds would be expected.

Likewise, to be expected is the occurrence of chert nodules within similar clay beds near the Mill Hopper sink. Such chert nodules have been collected at a clay exposure on the north side of the Newberry Highway approximately 5½ miles west of Gainesville. There, the chert nodules occur in the most weathered zones and show traces of bedding continuous with that of the clay.

Lithologic Pecularities

In the Devil's Mill Hopper all beds are characterized by variable lithology. A number of these variations are quite unusual.

Locally, in weathered zones, the clay grades vertically and laterally into lenses and irregular masses of limestone and sandstone. When the massive clay dries it shrinks considerably, breaking up into small angular blocks (see figure 1). The clay breaks with essentially a horizontal parting that results from an original horizontal bedding. Probably through the aid of ground water, calcium carbonate is precipitated in cracks between the blocks of clay and at times grains of quartz sand are brought in mechanically, resulting in an interlacing network of carbonate or cemented sand grains surrounding all of the clay blocks. At some exposures, blocks of clay have fallen out displaying the network (figure 2). Whether ground water could continue to carry the clay away, depositing calcium carbonate from solution and bringing in clastic quartz sand, or whether in cases replacement of clay by calcite could take place, eventually resulting in a "limestone" or "sandstone" is not known (figures 3, 4 and 5). Such lenses and irregular masses of "limestone" and "sandstone" would be secondary in origin.

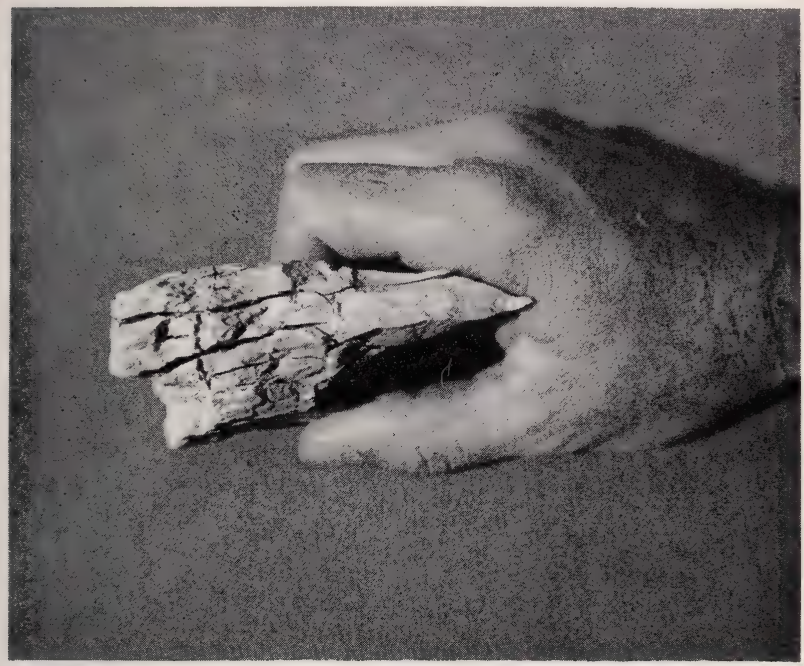

Figure 1. Clay showing partings developed on drying. When collected, the clay was damp and massive with no visible breaks. Specimen from bed 3 at the Devil's Mill Hopper. (Photograph by R. L. Day)

When the weathered surfaces, which show the blocks of clay surrounded by films of carbonate or cemented quartz sand, are removed, the fresher material is noted to be blocky clay that is not characterized by the interlocking network. In places, these fresher clays contain stringers of carbonate or quartz sand.

Included in the clays, particularly near the top of the clay sequence, are nodules and concretions of dense dolomitic material (figure 6) as much as 1 foot in diameter. Some of these enclose small clay blocks. In all cases observed, these blocks of clay have a horizontal orientation and are more numerous and fresh near the outer edges of the dolomitic nodules. Relict blocks occur farther inside the boulders. It is believed that these boulders of dolomitic material are secondary in origin having in some way formed in the clay. Chemical analyses of the clay usually indicate a magnesium oxide content ranging from about 2 to 5 percent.

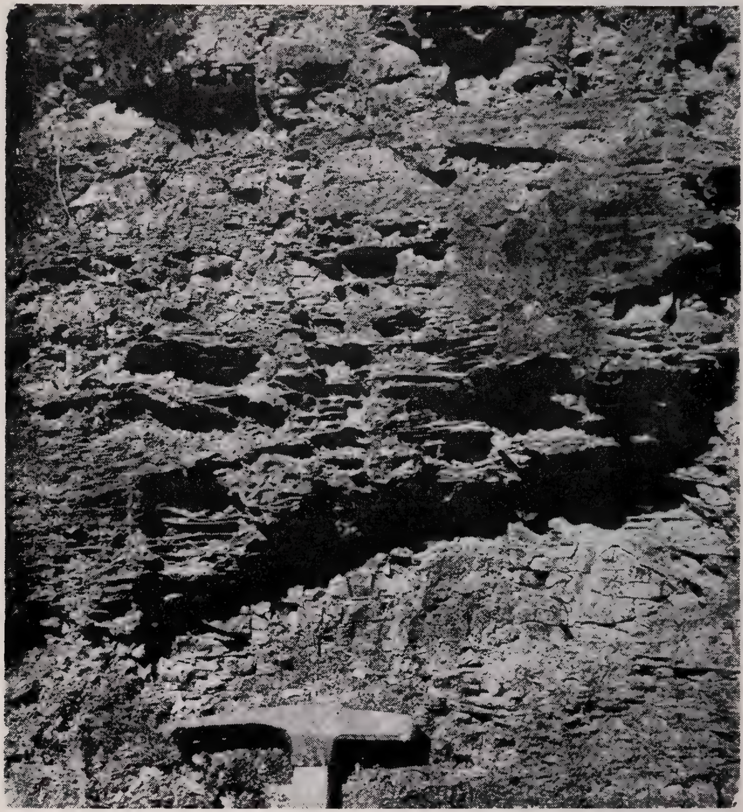

Figure 2. Clay of bed 7 at the Devil's Mill Hopper displaying network of calcite. The calcite with some included quartz sand has been deposited between blocks of clay and is best shown where blocks of such clay have fallen out. (Photograph by R. L. Day)

Occasional blocks and masses of clay having a horizontal orientation occur in the dense dolomitic material of bed 8. In some exposures it is clearly seen that this dolomitic material and the clays grade into each other, with bedding in the clay continuing uninterrupted into the dolomite. It appears that this bed of dolomite is secondary in origin, representing large concretionary masses.

Description of Beds 4 and 6

Beds 4 and 6 are entirely different from beds 3, 5 and 7. Beds 3, 5 and 7 are composed largely of clay. Beds 4 and 6 occur as lenses and have the appearance of intraformational breccias and conglomerates. They consist mainly of sandy limestone containing angular and rounded blocks of the surrounding clay as well as grains and pebbles of phosphate. There is no specific orientation of the blocks of clay, rather these two beds are characterized by the random orientation of the clay blocks (figure 7). In places, shells of *Pecten acanikos* Gardner and *Carolia floridana* Dall are numerous. Thin sections of this limestone reveal included quartz sand, phosphate particles, clay pellets, orthoclase, plagioclase and microcline. No indications of replacement were seen. The feldspars appear to be clastic.

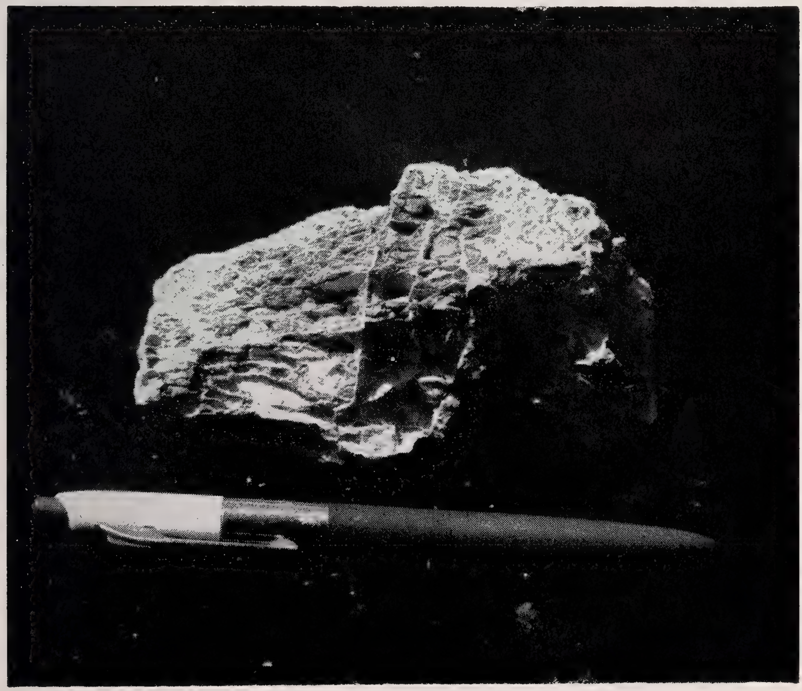

Figure 3. More advanced stage of box-work development than shown in figure 2. All of the clay blocks and remnant blocks of clay have a horizontal orientation. In this specimen from bed 3 at the Devil's Mill Hopper, calcium carbonate is an abundant component of the material.

These beds may have been formed by the "churning up" of materials during a storm. Sessile barnacles that have been torn from their sub-stratum occur in the sediments. Some of the blocks of clay have been bored from various sides by mollusks indicating that the blocks of clay were washed around on the ocean floor. The clay in the blocks is tenacious and can withstand some abrasive action.

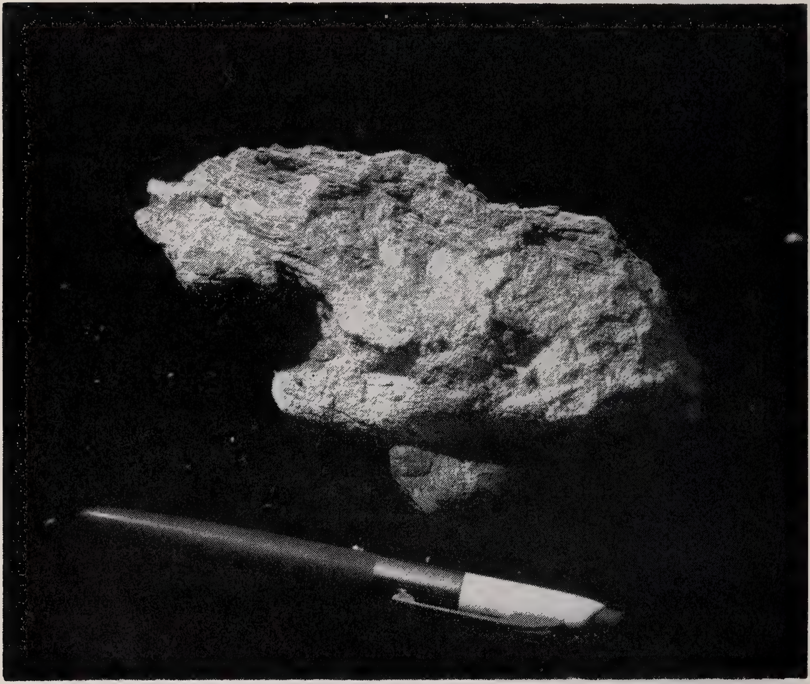

Figure 4. Specimen from bed 3 at Devil's Mill Hopper. Calcium carbonate is the dominant component. Numerous remnants of clay have essentially a horizontal orientation.

It is not understood how the clay could have been sufficiently lithified to be fragmented when subjected to strong wave action. Was it necessary for the clay to be exposed to the atmosphere, hardened and cracked through desiccation, or could the lithification have taken place under marine conditions? Exposure to the atmosphere is the choice most commonly held in such cases.

At the Mill Hopper there are all gradations from the intraformational breccias and conglomerates to massive clay. In places it appears that the clay has been only slightly broken up by waves and the clay blocks only slightly shifted. Calcium carbonate with included quartz sand has been deposited between such blocks. This carbonate occasionally contains fossil shells of marine mollusks. These shells have suffered no compaction. Small, angular fragments and slightly rounded particles of the clay occur in the cementing material. In cases, it appears that the calcareous sediment has been forced into the cracks between clay blocks under slight pressure. For example, some thin sections have revealed that occasionally clay material was dragged from clay blocks by the penetrating calcareous sediment.

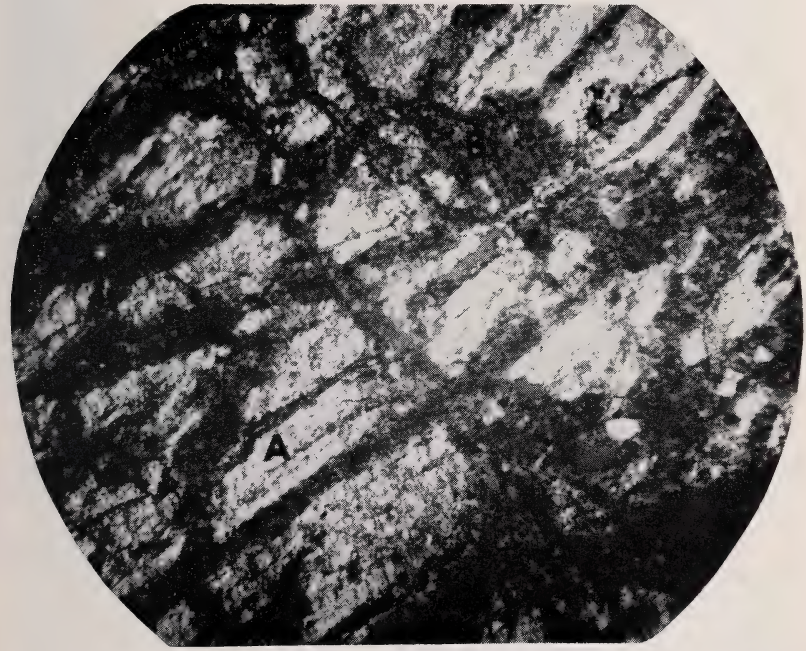

Figure 5. Photomicrograph of sediments consisting of clay particles (A) surrounded by calcite. A few grains of quartz occur in the calcite. Use of a gypsum plate makes it clear that all blocks and remnants of clay have the same orientation. X37.

Throughout beds 4 and 6 (the intraformational breccias and conglomerates), the fossil shells are composed of calcite. In beds 3, 5 and 7 (those consisting largely of clay), fossils are rare and occur as impressions or as silicified shells. The clay probably is the source of the silica for the silicification of the fossil shells. Because the fossil shells in beds 4 and 6 are embedded in limestone, those shells have not been affected as much by the silica from the clay and have not been silicified.

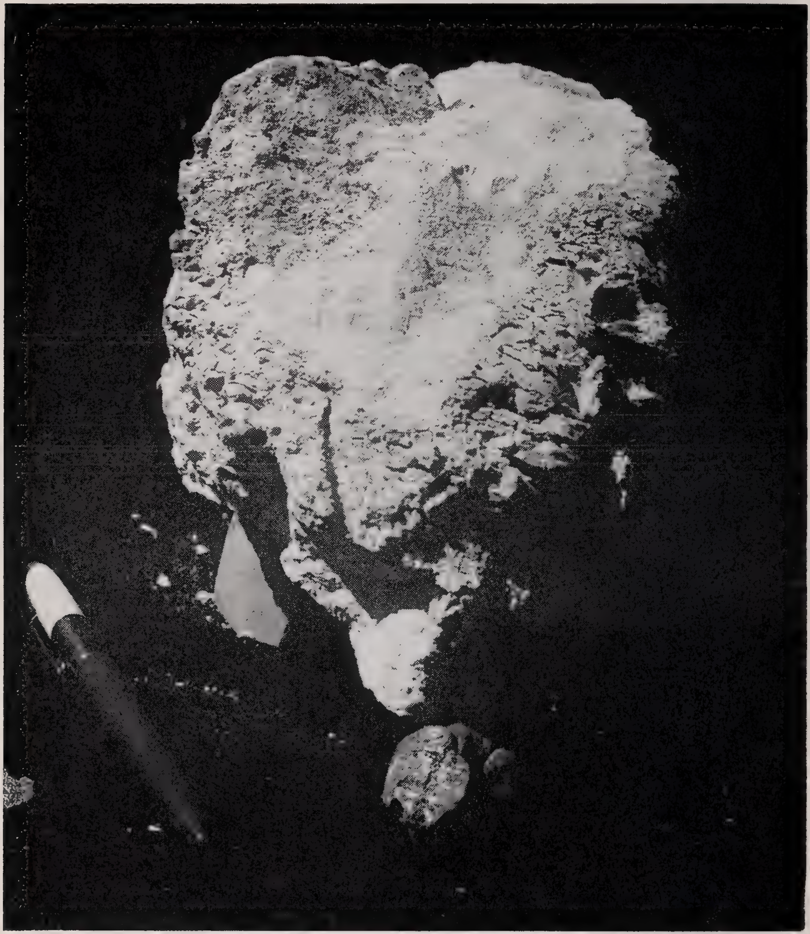

Figure 6. A nodule of dolomite that was embedded in the clay of bed 7 at the Devil's Mill Hopper. Note the blocky clay surrounding the whitish dolomite that occupies the center of the specimen. Blocks and remnants of this clay are present in such dolomitic nodules and are more abundant near the edges of the dolomite. These included blocks and remnants of clay have a horizontal orientation as do the blocks of clay in which the dolomite is embedded.

Another feature of interest concerning these beds is that pebbles and grains of phosphate are much more numerous than in the clays of beds 3, 5 and 7. It has been noted in a number of exposures of Hawthorne sediments that similar zones of limestone with included calcite fossils and angular and rounded fragments of surrounding sediments contain more pebbles and grains of phosphate than the enclosing beds.

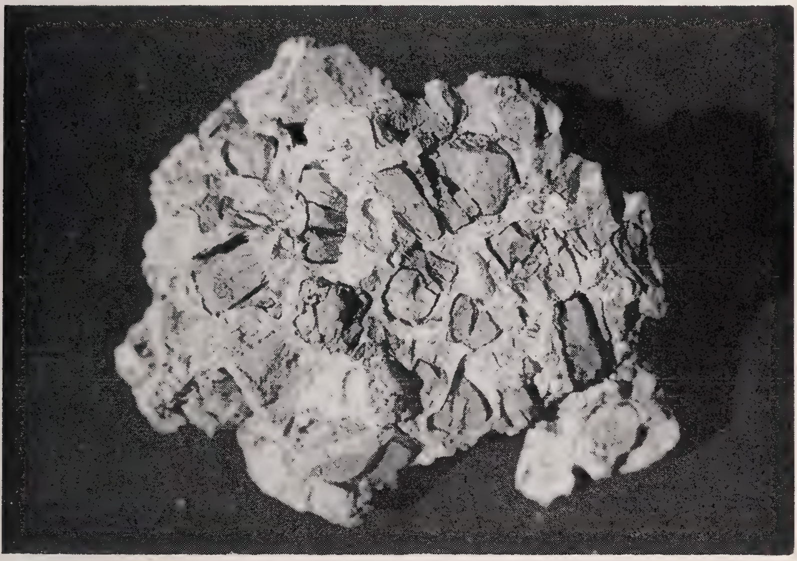

Figure 7. Angular and rounded blocks of clay embedded in limestone of bed 4 at the Devil's Mill Hopper. Note that there is no definite orientation of the blocks of clay. The clay blocks have shrunk on drying, leaving a space around each. This space in the picture appears as a black fringe around the blocks. Long diameter of largest blocks approximately 1 inch. (Photograph by R. L. Day)

Phosphate Reaction Zone

It appears that locally the upper surface of the limestone of bed 9 has been replaced by phosphate. Apparently, phosphorus dissolved from the phosphate grains and pebbles of bed 10 by downward percolating ground water has replaced part of the carbonate content of bed 9. This would represent hard-rock type phosphate in the process of being formed.

Even though the phosphate reaction zone appears obvious, chemical analyses were run in an attempt to determine the degree of replacement. One sample was taken about 6 inches down from the upper surface of the limestone. A second sample was selected approximately 2½ feet below the upper surface of the limestone and below the apparent phosphatized zone. The upper sample had a Bone Phosphate of Lime content of 43.3 percent and the lower sample a BPL content of only 2.9 percent. These analyses were made by chemists of the American Cyanamid Company.

The apparent phosphate reaction zone at the Mill Hopper is of considerable interest, because in some nearby areas of Alachua County no such zone is being developed in limestone even though phosphatic sediments are being removed from over the limestone by sub-aerial weathering and erosion. For example, no indications of a reaction zone can be detected in parts of south-central and southeastern Alachua County where highly weathered remnants of the phosphatic Hawthorne formation rest on Ocala limestone.

The questions raised by this inconsistency in the formation of hard-rock type phosphate in Alachua County constitutes a part of the larger problem of the distribution of hard-rock phosphate deposits throughout Florida. The problem can be stated as follows: Why in some areas of Florida has the phosphorus leached from sands and clays containing phosphate particles replaced underlying limestone (as along the breached crest of the Ocala arch), whereas throughout other large areas of Florida no deposits of hard-rock phosphate occur where the phosphatic Hawthorne has been eroded from over the Ocala limestone? Some of the possibilities that would normally be considered to explain the lack of hard-rock phosphate in the latter areas include the scouring action of advancing Pleistocene seas, the erosional work of streams, facies changes in the Hawthorne formation and bird rookeries. It should be recognized that these factors may have played a role locally in parts of Florida, but would not explain the apparent formation of hard-rock phosphate at the Devil's Mill Hopper and the lack of formation of such deposits in southeastern Alachua County.

Drainage conditions and the character of the ground water unquestionably are important factors in the degree of development of secondary deposits by replacement and open-space filling. Subsurface drainage conditions vary from place to place throughout Florida today and undoubtedly have varied greatly during Late Tertiary and Quarternary times. It seems probable that the drainage conditions and the nature of the ground water have been the critical factors and if completely understood would prove sufficient to explain the distribution of the secondary, hard-rock type phosphate deposits of Florida.

ACKNOWLEDGMENTS

The late Dr. John L. Rich and Dr. William F. Jenks of the University of Cincinnati; Professor Harold K. Brooks, formerly of the University of Cincinnati; and Drs. Walter Auffenberg, Pierce Brodkorb and Richard A. Edwards of the University of Florida spent many hours in reading the report from which this material was taken. They have offered valuable suggestions.

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LITERATURE CITED

COOKE, CHARLES W.

1945. Geology of Florida. *Florida State Geol. Survey Bull.*, 29 : 339 pp.

GRIM, RALPH E.

1933. Petrography of the fuller's earth deposits, Olmstead, Ill., with a brief study of some non-Illinois earths: *Econ. Geol.*, 29 : 4, 344-363.

MANSFIELD, GEORGE H.

1940. Clay investigations in the southern states, 1934-35; Introduction. *U. S. Geol. Survey Bull.*, 901 : 1-22.

PIRKLE, E. C.

1956. The Hawthorne and Alachua Formations of Alachua County, Florida. *Quart. Jour. Florida Acad. Sci.*, 19 : 4, 197-240.

1957. Economic Consideration of Pebble Phosphate Deposits of Alachua County, Florida. *Econ. Geol.*, 52 : 4, 354-378.

VERNON, ROBERT O.

1951. Geology of Citrus and Levy Counties. *Florida State Geol. Survey Bull.*, 23 : 256 pp.

THE PROBLEM OF BIAS ON THE PART OF THE RESEARCHER IN THE SOCIAL SCIENCES

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Florida Southern College

The Problem of Bias

In a recent issue of *The Saturday Evening Post,* E. J. Kahn, Jr., a profile writer for the *New Yorker,* was quoted as having said that when a reporter interviews a celebrity, "*he automatically loses his objectivity as a reporter.* He identifies himself with his subject rather than taking a dispassionate look at him. In a sense (he) is writing what the subject and his loyal fans would *like* to read, rather than the simple truth." (Martin, 1957: 107, italics not in the original).

This represents the general problem of bias as we are concerned with it. The manner in which an investigator's personal feelings, emotions, and judgments tend to detract from his reporting the "simple truth."

While the problem is general, it is particularly significant in the Social Sciences for, as William J. Goode, professor of Sociology at Columbia University mentions, "*moral involvement* with his subject may tempt the Social Scientist rather more than the physical scientist to bias his results in favor of his own values." (Goode and Hatt, 1952: 19).

Bias and the Scientific Method

The potential influence of bias is evident throughout the steps of the scientific method.

The selection or the recognition of a problem for investigation often depends on the personal value judgments of the investigator, for they are the criteria against which he judges the problem either worthy or not worthy of investigation.

Once the problem has been determined, the researcher proceeds to gather the facts that are related to the problem. And yet it is not conceivable that even the most competent scientist could collect *all* of the relevant data, but has, as Weber points out, " . . . selected from an absolute infinity [of facts] *a tiny portion* with the study of which he concerns himself." (Weber, 1949: 82, italics not in the original). If we can assume then, that the researcher has to make a choice from the abundant data that is available to him, we must also assume that his value judgments will, once again, be his criteria of what is important. It is evident that he will select that which *he* feels is important and reject that which he feels is not.

From the facts that the investigator has chosen from the infinity of facts that were available to him, he forms an hypothesis. This hypothesis explains, in a coherent manner, the collected facts and usually provides a proposition that can be tested to determine its validity. The formulation of this hypothesis and the method used in its verification are both subject to the researcher's bias. This bias is present to such an extent that Paul Hanly Furfey, professor of Sociology at the Catholic University of America, has remarked, "it frequently happens that two scientists to whom the same data are available reach mutually inconsistent results." (Furfey, 1953: 173).

Hence, from the inception of a research problem, through each step of the scientific method, personal value judgments can inhibit the objectivity of the investigator. And when, as is most often the case, these value judgments are *unconscious* influences, the greatest deterrent to objective investigation results.

EXAMPLES OF BIAS IN RESEARCH

Examples of how bias has influenced the research of scholars are numerous both in the original works, and as they have been pointed out by authors discussing the problem of bias. For the purpose of this paper three examples have been selected to illustrate the problem as it has affected studies in History, Sociology, and Religion.

In the first chapter of Arnold Toynbee's book, *An Historian's Approach To Religion,* the author discusses the problem of overcoming self-centeredness in historical investigation. Toynbee is concerned with the subjective involvement of the historian with his study and states that the historian is often a prisoner of his own time and place. He feels that this has been the case with even the most highly gifted historians and uses Gibbon's *The History Of The Decline And Fall Of The Roman Empire* as his illustration. Toynbee indicates that while Gibbon appears to have chosen a subject that was sharply detached from the life of his own generation, his judgment was influenced by his own times in at least three ways. First, he chose his subject by a personal experience which linked the Roman age of the Antonines with the Rome of A.D. 1764. Secondly, he was able to enter imaginatively into the life of the Roman Empire in the Antonine age because he felt an affinity between this and the life of his own generation in a modern western society. And finally, he was concerned to inquire whether his own society could ever be overtaken by the same disaster that had actually overtaken the Roman Empire. (Toynbee, 1956: 9). And so it can be seen that Gibbon has not presented an impersonal history but rather one that depended in many instances upon the experiences and feelings of the man who wrote it.

Gunnar Myrdal presents a more general illustration in the field of Sociology; in an appendix to his *An American Dilemma,* he gives a lengthy discussion of how bias has influenced and is influencing scientific investigation dealing with the Negro problem in America. Until recently, says Myrdal, white scholars have worked more or less consistently in the interests of the dominant white group's need for the rationalization and justification of the color caste system. In spite of the fact that the emphasis upon environment as a cause of the differences between social groups has produced *more* objectivity, this bias of justification is *still* influencing research. Another important bias affecting investigation concerning the Negro problem in America is the position of the scientist on the "radical-conservative scale." Myrdal points out that case after case demonstrates the tendency for the radically minded investigator to champion the cause of the underdog in his research; whereas the conservative researcher will tend to favor existing conditions. A third problem mentioned by Myrdal is the degree to which a scientist is prepared to study *unpopular* subjects and to state plainly and clearly any *unpopular* conclusions derived from his findings. (Myrdal, 1944: 1035-40). These are only three of the many possible ways in which the "personality" of the sociologist can enter what should be his objective research.

Religion is probably that field of the Social Sciences most susceptible to the influence of bias; its history is filled with reliance upon emotion, intuition, dogma, and faith, rather than impartial evaluation of evidence. In recent years the trend has been towards an infusion of sound historical method and scholarly research as is evidenced by the compilation of the new *Revised Standard Version of the Bible.* But, while some scholars have achieved a high degree of objectivity in the field of religion, many others expressing "objectivity" as their criterion are still influenced through their bias. A case in point is Dr. George S. Duncan, principal of St. Mary's College, who states in the preface of his book, *Jesus, Son Of Man* that in presenting a modern portrait of Jesus, the research must be "critical and constructive" and that the interpretive judgment of the researcher must do " . . . full justice to the facts . . . " And yet, he goes on to say in the same preface that "the portrait of Jesus which finds expression in the *faith of the church* is *not* to be dismissed as the product of religious bias." (Duncan, 1949: viii-ix—italics not in the original). As the church portrait of Jesus is based upon such considerations of faith as his virgin birth, divinity, and resurrection, one must infer the influence that bias has had upon this work. The seeking of facts to fit a preconceived picture or idea is especially prevalent in religious research.

Some Methods That Have Been Suggested to Control Bias in Research

Having stated and illustrated the fact that bias *does* exhibit the objectivity of research, we come to the problem of its solution. Can the investigator in the Social Sciences overcome his bias, and, if so, how and to what extent?

Those authors who deal with the problem vary in their opinions as to the degree to which bias can be overcome but seem to agree that the researcher cannot obtain absolute objectivity. Pauline Young remarks that, "Few persons ever acquire even a passably consistent objectivity, especially with regard to social problems." (Young, 1939: 88-89). And Morris Cohen states with more emphasis that to clear the mind of all prejudgments and anticipations is not possible. (Cohen, 1931: 81).

Assuming this to be true—that bias cannot be wholly eliminated—then it is necessary to examine some of the methods that have been suggested to reduce its effect upon research.

The basic step in the reduction of the influence of bias is, as Myrdal states, "an *awareness* of the problem of bias . . . " (Myrdal, 1944: 1036—italics not in the original). Further, the investigator must not only be conscious of the problem of bias, but he must also be conscious of the fact that the problem is relevant, that it directly concerns *him* and *his* research, and that he must not regard the problem with a casual or an indifferent attitude.

Many authors have been content to leave the issue at this point, assuming that once the problem has been acknowledged it no longer holds a threat to objectivity. This is misleading, for it is evident that while the biases have been discovered, they have not been controlled. Three distinct treatments of the problem—each of which goes beyond mere awareness—are found in Toynbee, Furfey, and Myrdal.

Toynbee feels that the historian, in order to lessen the influence of his bias, must first recognize what his personal or self-centered standpoint is and then consciously and deliberately " . . . shift his angle of vision away from the self-centered standpoint." (Toynbee, 1956: 4). If, however, this method is to be adopted, the possibility that in his attempt to steer away from one set of values, the researcher may merely fall into another, must be understood and avoided.

Furfey stresses the psychological aspects concerning the matter of bias and its control. He feels that if the personal life of the researcher is full of unresolved tensions, these tensions will affect his scientific work. It is of paramount importance, says Furfey, that the investigator understands himself, for the degree to which he does understand himself correlates with the degree of objectivity that he is able to attain. (Furfey, 1953: 197). This method is effective in so far as the researcher is able to analyze himself correctly and thoroughly. However, as this often requires technical training, it would be a cumbersome method upon which to rely solely, and would be more effective if used in conjunction with other methods.

Myrdal approaches the problem from still another viewpoint. He suggests that to reduce the effect of bias, the investigator must decide on and state a set of "value-premises" upon which his investigation will be based. These value-premises are selected for their relevance to the problem that is to be considered and for their consistency with each other. Myrdal employed this method in his survey of the American Negro problem and selected as his major value-premise the "American creed." Briefly, he defined this creed as the ideal of equal rights of all citizens in America and then proceeded in his investigation, consciously weighing the existing situation against this creed. In this way, says Myrdal, the investigator has taken the precautions to avoid *hidden* biases, has presented his value-premises so that the reader is aware of them and can criticize the work in light of them, and has *consciously* proceeded in an investigation that has been dependent upon his value-premises, thereby increasing his objectivity, for all investigations depend upon values whether hidden or acknowledged. (Myrdal, 1944: 1041-1066, 24-25). Myrdal implies that the weak spot in this method is in the selection of value-premises which are relevant and consistent.

SUMMARY

Thus, we have examined the problem of bias in research and have found that: 1. The problem is general, but is particularly significant in the Social Sciences. 2. The problem is a potential influence throughout each step of the scientific method. 3. Bias has, in fact, unconsciously reduced the objectivity of the investigator in actual research problems. 4. That the methods proposed for its solution still leave a wide margin for error.

A general suggestion by this author is that the problem of bias in research be introduced at the undergraduate level of college, either as a part of a course in research method or as an accepted preliminary to any research assignment, thereby producing a definite awareness of the problem on the part of the scholar prior to his graduate level work.

However, further investigation of this problem is essential if social and historical research is to attain any high degree of objectivity. If Furfey is correct when he states as late as 1953 that "There is no satisfactory discussion of the control of bias in productive thinking" (Furfey, 1953: 176), then we can assume that social scientists have been unaware of the problem, have underestimated its importance, or have simply neglected to pursue it to a satisfactory conclusion.

I should like to thank Dr. Ralph W. Odom of the Department of Religion at Florida Southern College without whose kind suggestions and encouragement this paper could not have been written.

LITERATURE CITED

COHEN, MORRIS R.

1931. *Reason and Nature.* The Free Press, Illinois.

DUNCAN, GEORGE S.

1949. *Jesus, Son of Man.* The Macmillan Company, New York.

FURFEY, PAUL HANLY

1953. *The Scope and Method of Sociology.* Harper and Brothers, New York.

GOODE, WILLIAM J., and PAUL K. HATT

1952. *Methods in Social Research.* McGraw-Hill Book Company, Inc., New York.

MARTIN, PETER

1957. I Call on Mike Wallace. *Saturday Evening Post,* for November 23, p. 107.

MYRDAL, GUNNAR

1944. *An American Dilemma.* Harper and Brothers, New York.

TOYNBEE, ARNOLD

1956. *An Historian's Approach to Religion.* Oxford University Press, London.

WEBER, MAX

1949. *The Methodology of the Social Sciences.* The Free Press, Illinois.

YOUNG, PAULINE U.

1944. *Scientific Social Surveys and Research.* Prentice-Hall, Inc., New York.

A NEW FAMILY OF MIOCENE SALAMANDERS FROM THE TEXAS COASTAL PLAIN[1]

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Miocene urodele remains from North America are apparently quite rare in collections. Only two finds have been reported. Sirenid vertebrae are available from the Lower Miocene of Florida (Goin and Auffenberg, 1955), and a large skull is known from the Middle Miocene of Texas (Taylor and Hesse, 1943). Thus a number of large vertebrae now available from Lower and Middle Miocene deposits of the Texas Coastal Plain are of considerable interest. There is reason to believe that these vertebrae are to be referred to the same species as that described by Taylor and Hesse. Most fossil salamanders have been described on the basis of vertebrae; these are the most common elements and their characters are known to be as diagnostic and less variable than most cranial elements. For this reason the vertebral elements from the Texas Coastal Plain are described below. Unfortunately, the skull described by Taylor and Hesse was not associated with any vertebrae, though some of the vertebral elements described below originate from the same formation and the same general area.

The skull (Museum A. and M. College of Texas, No. 2234) described by Taylor and Hesse (1943) was designated as the type of a new genus and species, *Batrachosauroides dissimulans*. The specimen was collected 3 miles northwest of Coldspring, San Jacinto County, Texas, Fleming formation, Hemigfordian Age (see Quinn, 1955 and Wilson, 1956, 1957 for a discussion of the stratigraphic relations of fossil beds in the Texas Miocene).

The generic characters of *Batrachosauroides* follow (*fide* Taylor and Hesse, *op cit.*); " . . . an elongated premaxillary spine which separates the nasals; bony pterygoids; the frontals and to a lesser extent, other dorsal anterior cranial elements, sculptured; the occipital condyles with a convex surface apparently somewhat stalked and rather widely separated; premaxilla single, toothed; toothed maxillaries present; vomerine teeth present; mandible articulartion by a ball and socket joint, the ball being the ossified articulare."

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[1] A contribution from the Department of Biology and the Florida State Museum, University of Florida.

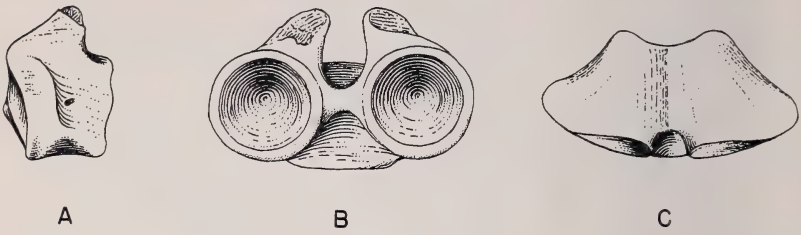

Figure 1. University of Texas, Bureau of Econ. Geol., Vert. Pal. Coll., No. 31057. Atlas referred to *Batrachosauroides dissimulans,* Polk County, Texas, Middle Miocene. A.—Lateral view. B.—Anterior view. C.—Ventral view.

On the basis of the skull the systematic position of *Batrachosauroides* is not definitely established. However, based on characters afforded by the type, it seems reasonable to refer the genus to the suborder *Salamandroidea* Noble, at least tentatively. A number of structural characters will separate it from the other subordinal groups of the urodeles.

The familial relationships are even less clear. Taylor and Hesse contended that of the three families of the Salamandroidea, *Batrachosauroides* was probably closer to the Amphiumidae than to either the Plethodontidae or the Salamandridae. This contention was based on the presumed absence of opisthocoelous vertebrae, separating it from the Salamandridae; and the presence of parasphenoid and splenial teeth, separating it from the Plethodontidae.

The skull suggests a salamander the size of *Amphiuma.* The sculpturing of the anterior skull bones, presence of a temporal ridge and the general disposition and shape of the various cranial elements in the fossil are all characters found in *Amphiuma.* However, the skull of *Batrachosauroides* was said to differ from that of *Amphiuma* in possessing a well developed series of splenial teeth. Unfortunately, the presence or absence of an ethmoid, a feature peculiar to the Amphiumidae, cannot be determined in the fossil.

Apparently no vertebrae were collected with the type, so that it is difficult to see how Taylor and Hesse determined that the vertebrae were amphicoelous and not opisthocoelous. All of the Salamandridae and some of the Plethodontidae are known to possess opisthocoelous vertebrae, though the condition seems to have a different structural basis in each family (Soler, 1950). Numerous vertebrae, tentatively referred to *Batrachosauroides dissimulans,* are now available. These are all strongly opisthocoelous. They belong to a large species of salamander found in the same bed as that of the type skull. No other salamander vertebrae are known from these, or associated beds. In the absence of articulated material the reference of these vertebrae to the same genus and species as that of the type seems reasonable.

In the generic description of *Batrachosauroides* and in the discussion of relationships Taylor and Hesse state that the premaxillaries are single, yet in the description of the separate elements they state that the premaxillary " . . . may . . . have been in two parts originally." However, they go on to state that "Closer scrutiny . . . points to the greater probability that it is a fractured single element." If the premaxillary was double in life and the vertebrae are correctly referred, the two most important characters used to separate *Batrachosauroides* from the Salamandridae become points of similarity rather than points of dis-similarity.

Sculpturing of the cranial elements is found in at least some individuals in certain salamandrid genera (*Salamandrina,* etc.) and some Plethodontidae (*Aneides, Manculus*), so that this character is not peculiar to the Amphiumidae among the Salamandroidea.

By sectioning one of the fossil vertebrae it has been possible to show that the opisthocoelous condition of the fossils is similar to that described as hemicoelously opisthocoelous by Soler (*op cit.*), *i.e.*; like that in the Desmognathinae among the Plethodontidae, rather than like that in the Salamandridae.

Several atlantes referred to *Batrachosauroides* are available from the Texas Coastal Plain Miocene. They are quite simple (fig. 1), unlike the more complex elements of the Plethodontidae, but more similar to those of the Salamandridae and Amphiumidae.

On the basis of the above it is fairly obvious that *Batrachosauroides dissimulans* cannot clearly be placed in any of the existing families of the Salamandroidea, or, for that matter, in any recent urodelian family. It is here suggested that the fossil form be considered representative of a new family of salamanders, now extinct, but known to exist in at least the Miocene of North America.

Order *URODELA*

Suborder SALAMANDROIDEA

Family BATRACHOSAUROIDIDAE n. fam.

DIAGNOSIS.—*Skull*: Differs from the Salamandridae and Plethodontidae, but not the Amphiumidae, in possessing a well developed median parietal ridge. In addition, it differs from the Plethodontidae in being provided with pterygoids and splenial teeth in the adult. From the Salamandridae it further differs in possessing (presumably) a single premaxillary. From the Amphiumidae it differs in possessing splenial teeth. From the Desmognathinae among the Plethodontidae it also differs in possessing a prefrontal and lacking parasphenoid teeth. *Vertebrae*: The atlas differs from that of the Plethodontidae in lacking the small posteriorly directed basipophysial processes found in this element in *Batrachosauroides*. Furthermore, the ventral surface of the centrum is more or less horizontal when viewed from the side, not directed downwards posteriorly as in the Plethodontidae. The centrum is considerably shorter than that in the Plethodontidae and the Salamandridae, and lacks the large paired subcentral nutritive foramina found in the Amphiumidae. In general outline the atlas is more similar to those found in the Cryptobranchoidea and Proteida than to those found in the genera of Salamandroidea.

The dorsal vertebrae differ from those of the Amphiumidae and most Plethodontidae in being opisthocoelous, in which the anteriorly directed condyle is osseous. From the Salamandridae the vertebrae of the fossil differ in being hemicoelously opisthocoelous, rather than pseudocoelously opisthocoelous. From the Desmognathinae among the Plethodontidae it differs chiefly in lacking the posteriorly directed "pterypophysial"-like processes arising from the dorsal surfaces of the postzygapophyses of the anterior dorsal vertebrae. From the Amphiumidae the fossil vertebrae also differ in lacking the small pair of anteriorly directed accessory basipophysial processes found in this family on the antero-ventral edge of the centrum. In addition to the above, the transverse process is located more posteriorly than it is in any of the presently recognized families of the Salamandroidea, being more similar to those found in the Cryptobranchoidea and Proteida.

An additional diagnostic character of considerable interest is the large size of the fossil form, separating it from all known definite

Plethodontidae and Salamandridae, either fossil or Recent. *Batrachosauroides* presumably attained a length of three feet.

A number of Miocene salamanders are known from Europe. Most of these are clearly salamandrids, similar to *Batrachosauroides* only in possessing opisthocoelous vertebrae, but obviously not closely related to the North American form. *Dehmiella* is currently considered a Miocene Plethodontid from Europe, though it seems abberant in certain regards. Regardless of the final nomenclatorial assignment for this and several other somewhat problematical fossil genera it is significant for purposes of this paper that it differs from *Batrachosauroides* in a number of important vertebral characters. In addition, several species of *Megalobatrachus* (Cryptobranchoidea) are known from the European Miocene, all of which differ from *Batachosauroides* in cranial and/or vertebral characters. A single specimen of an Oligocene salamandrid (*Paleotaricha*) is known from North America. It also differs markedly from the Texas Miocene genus. From what information is available it appears that no other fossil or Recent genus of Urodele clearly bears a close relationship to *Batrachosauroides.* As far as is presently known the family Batrachosauroididae contains only the type genus. The removal of *Batrachosauroides* from a problematical position in the Amphiumidae leaves the latter with a fossil history extending back to but the Pleistocene of Florida.

The possibility still exists that the large vertebrae from the Miocene of the Texas Coastal Plain are not to be referred to *Batrachosauroides.* If in the future this is found to be the case the family should be found to be valid on cranial characters alone, and the vertebrae, being quite distinctive, should form the basis of the description of a new genus and species of salamander, presumably familially removed from all other known salamandroids, both fossil and Recent. A full description of the vertebrae referred to *Batrachosauroides dissimulans* follows. It is based on 18 vertebrae from several fossil sites in eastern Texas.

The vertebrae obviouly represent a number of individuals. In centrum length they vary from 8.5 to 15.1 mm. Some are quite eroded and/or broken. In the remaining better specimens relatively little variation is discernible, except as follows: In the more anterior vertebrae the centrum is shorter in proportion to its width; the transverse process is directed slightly more dorsally and the hypapophysial keel is more ridge-like and better developed (with the exception of the first few vertebrae following the atlas-axis complex, where the keel is evidently flattened). The anterior portion of the base of the transverse process arises closer to the condylar lip. The neural spine appears to be thicker and the size of the neural canal is proportionately larger than in the more posterior vertebrae.

A typical dorsal vertebra is described below (University of Florida 2013) and illustrated in figure 2.

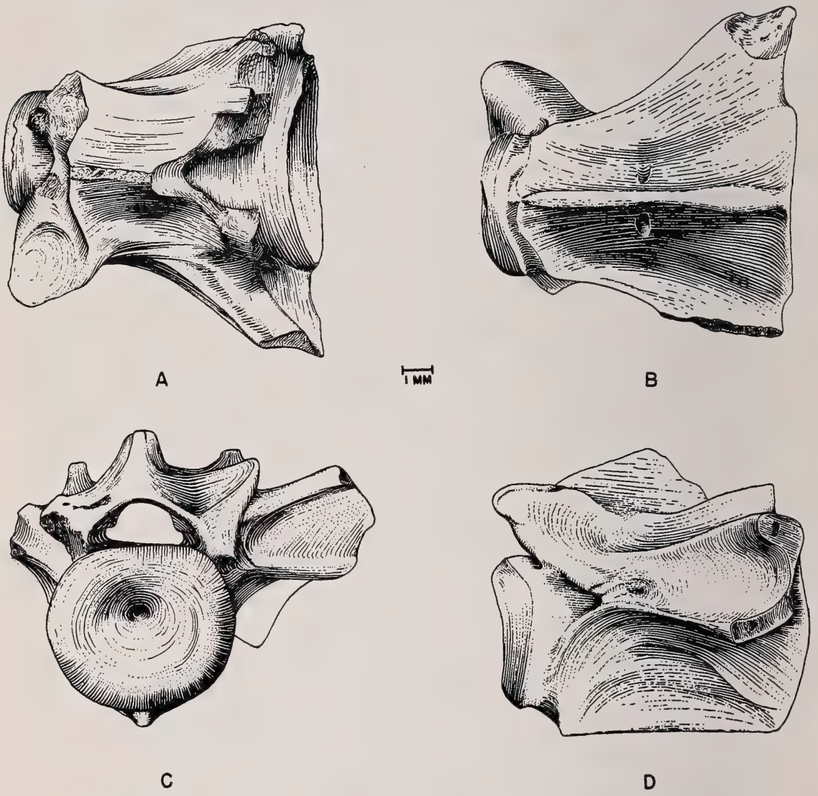

Figure 2. University of Florida, Vert. Foss. Coll., No. 2013. Dorsal vertebra referred to *Batrachosauroides dissimulans*, San Jacinto County, Texas, Middle Miocene. A.—Dorsal view. B.—Ventral view. C.—Anterior view. D.—Lateral view.

U.F. 2013—a large, opisthocoelous dorsal vertebra. Measurements (in mm.): length of centrum along mid-ventral line, 12.3; width of vertebra at narrowest part of the zygapophysial ridges, 8.3; height of vertebra from lower margin of the centrum to a line drawn between the facets of the prezygapophyses, 11.0. Centrum longer than high; glenoid cavity and cotyle rounded; notochordal canal well defined in the center of the cotyle; condyle well developed, with a rounded depression in the center; centrum provided with a ridge-like median hypapophysial keel, nearly straight when viewed from the side, on either side of which is one foramen; length of neural arch greater than the width of the centrum, and its width at the narrowest part of the zygapophysial ridges slightly greater than the width of the centrum. Neural canal slightly depressed when viewed from the front, and provided with a well developed median epipophysial ridge on its floor; articulating surfaces of the left prezygapophyses oval, but eroded, longer than wide, directed slightly more laterally than anteriorly when viewed from above; zygapophysial ridges not well developed, rounded; transverse process well developed, with two articular surfaces, the upper and lower laminae connected by a bony vertical septum, articular surfaces nearly even with the posterior edge of the centrum.

Unfortunately the posterior portion of the neural arch is broken away in all of the specimens available for study.

Material examined includes the following:

University of Florida Collections, No. 2013, one vertebra, Burkeville fauna location, Moscow locality, San Jacinto County, Texas, Fleming formation, Early Hemingfordian Age, Middle Miocene.

University of Texas, Bureau of Econ. Geol., Vert. Pal. Collections, Nos. 31057-120, three vertebrae, 31057-57, two vertebrae and 31057-94, one vertebra and 31057-94, one vertebra, all from Site 1, Polk County, Texas, Fleming formation, Early Hemingfordian Age, Middle Miocene; 31057, seven vertebrae, data "Polk County, Texas"; 31057-17, two atlantes, data "Polk County, Texas"; 40067-38, one vertebra, Hidalgo Bluff Locality, Texas, Lower Oakville formation, Arikareean Age, Lower Miocene; 40067-100, two vertebrae, one of which is very fragmentary, Hidalgo Bluff Locality, Texas, Lower Oakville formation, Arikareean Age, Lower Miocene. In addition two vertebrae obviously belonging to *Batrachosauroides dissimulans,* but without data or catalog numbers are in the University of Texas Bureau of Economic Geology Paleontological Collections. On the basis of the locality data the genus is known only from Lower and Middle Miocene deposits of Texas.

LITERATURE CITED

GOIN, C. J., and W. AUFFENBERG

1955. The fossil salamanders of the family Sirenidae. *Bull. Mus. Comp. Zool.,* 113(7): 497-514.

QUINN, J. H.

1955. Miocene Equidae of the Texas Gulf Coastal Plain. *Univ. Texas Pub.* (5516): 1-102.

SOLER, E. I.

1950. On the status of the family Desmoganthidae. *Univ. Kans. Sci. Bull.,* 33(12): 459-480.

TAYLOR, E. H., and C. J. HESSE

1943. A new salamander from the upper Miocene beds of San Jacinto County, Texas. *Amer. Journ. Sci.,* 241 : 185-193.

WILSON, J. A.

1956. Miocene formations and vertebrate biostratigraphic units, Texas Coastal Plain. *Amer. Assoc. Petrol. Geol. Bull.,* 40 : 2233-2246.

1957. Early Miocene entelodonts, Texas Coastal Plain. *Amer. Journ. Sci.,* 255 : 641-649.

A SYNOPSIS OF *GNAPHALIUM* (COMPOSITAE) IN THE SOUTHEASTERN UNITED STATES[1]

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In the southeastern United States, plants belonging to the genus *Gnaphalium* are commonly encountered. Species belonging to the section GAMOCHAETA are weedy and frequently occur in abundance, often intermixed. Identification of plants of the latter, particularly, is difficult. The treatment in Small's Manual (1933) is not helpful because several taxa have been reported from the area since its publication and other taxa have subsequently been variously re-interpreted. The treatments in recent manuals for adjacent areas northward of the range of Small's Manual (Fernald, 1950 and Cronquist in Gleason, 1952) are not in close agreement as to the delimitation of the taxa.

The present author is fully aware of the fact that a comprehensive revision on a world basis is necessary to a reasonable understanding of the taxonomy and nomenclature in *Gnaphalium* (see Fernald in Rhodora 37: 449-450, 1935, and 45: 478-479, 1943). This synopsis is offered in the hope that it will help to clarify, for the present, the identities of forms of *Gnaphalium* in the area under consideration.

My thanks are here expressed to the Curators of the Gray Herbarium, Harvard University, and the Herbarium of the University of Florida, Gainesville, for the loan of specimens needed for this study.

The range notes for each of the taxa catalogued below apply only to their distribution within the southeastern United States, *not* to their overall ranges.

KEY

1. Heads borne in terminal or panicled cymes; pappus bristles distinct at base, deciduous from the achenes separately; achenes glabrous.
    2. The heads borne in 1-several tightly compacted terminal cymes; leaves decurrent, cottony-lanate above and below . . . . 1. *G. chilense*

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[1] Support for this research was furnished by a grant from the National Science Foundation (G-2010). Herbarium assistance was made possible by a grant from the Research Council, Florida State University.

- 2. The heads borne in very numerous panicled cymes; leaves not decurrent, silvery pannose or lanate below, green and sparsely floccose or glandular above.
  - 3. Stems copiously cobwebby or densely floccose-woolly throughout . . . 2. *G. obtusifolium,* var. *obtusifolium*
  - 3. Stems glandular-viscid, not densely felted.
    - 4. The stems and upper leaf surfaces glandular-puberulent . . . . 3. *G. obtusifolium,* var. *micradenium*
    - 4. The stems and upper leaf surfaces glandular-villous . . . . 4. *G. obtusifolium,* var. *helleri*

1. Heads borne in spicate glomerules in the axils of bracteal leaves; pappus bristles united at the base, deciduous from the achenes together; achenes pubescent.
  - 5. Lower leaf surfaces densely silvery-pannose, the upper sparsely floccose, bright dark green and lustrous (when fresh) through the flocculum . . . . 5. *G. spicatum*
  - 5. Lower and/or upper leaf surfaces variously pannose, lanate, or floccose, but the upper never bright dark green and appearing lustrous through the tomentum.
    - 6. The lower leaf surfaces densely silvery-pannose or -lanate, the upper loosely woolly to glabrate, not silvery and much greener, the two surfaces conspicuously different . . . . 6. *G. purpureum*
    - 6. The lower and upper leaf surfaces not conspicuously different in color and texture.
      - 7. Woolly tomentum investing only the bases of the heads . . . . 7. *G. calviceps*
      - 7. Woolly tomentum investing about ⅔ of the heads.
        - 8. Upper cauline and bracteal leaves of the inflorescence linear-lanceolate to linear, their apices acute and with an almost cylindrical mucro . . . . 8. *G. falcatum*
        - 8. Upper cauline and bracteal leaves of the inflorescence oblanceolate to spatulate, their apices rounded to obtuse and with a small flat mucro . . . . 9. *G. peregrinum*

1. *Gnaphalium chilense* Spreng., Syst. Veg. 3: 480 (1826).

Annual, mostly 5-8 dm. tall. Stems single to the inflorescence, or more commonly with several erect branches from near the base.

Heads borne in compact cymose clusters terminating the single stems or on relatively long cymose peduncles. Stems and leaves copiously cottony-lanate throughout. Basal rosette leaves spatulate or oblanceolate; cauline leaves numerous, sessile and decurrent, gradually diminishing in size upward, oblanceolate to linear-attenuate. Heads hemispheric, or slightly broader than long, the bases invested in loose, woolly tomentum. Phyllaries distinctly yellowish or straw-color, thin-scarious, their tips broadly rounded or obtuse.

In sandy soil, old fields, roadsides, and open areas in general, coastal plain of North Carolina. Summer.

2. *Gnaphalium obtusifolium* L., var. *obtusifolium,* Sp. Pl. 851 (1753).

Including *G. obtusifolium,* var. *praecox* Fern., Rhodora 38: 231 (1936).

Biennial or annual, mostly 5-8 dm. tall; stems simple to the inflorescence branches, or with several erect stems from near the base. Heads borne in very numerous panicled cymose clusters, the inflorescence elongate-cylindrical to convex, or more or less flat-topped. Stems and lower leaf surfaces silvery-lanate, the upper leaf surfaces green and sparsely woolly to glabrous or papillate-glandular. Rosette leaves spatulate or oblanceolate; cauline leaves numerous, linear-oblanceolate. Heads campanulate, somewhat longer than broad. Phyllaries whitish or yellowish-white, scarious, their tips obtuse to short-acuminate, individually more or less woolly on their lower halves.

Common in old fields, open woods, clearings, and on roadsides, throughout the range. Summer and autumn.

3. *Gnaphalium obtusifolium,* var. *micradenium* Weatherby, Rhodora 25: 22 (1923).

This variety differs from the typical in its generally more slender stature and smaller leaves, and by its glandular-puberulent stem and upper leaf surfaces.

Rare in the range, known only from a single station in the coastal plain of South Carolina, and one in Clay County in the mountains of North Carolina. Summer.

4. *Gnaphalium obtusifolium,* var. *helleri* (Britton) Blake, Rhodora 20: 72 (1918).

G. helleri Britton, Bull. Torr. Bot. Club 20: 280 (1893).

Similar to var. *obtusifolium* in stature. Similar to var. *micraden-*

ium in that its stems and upper leaf surfaces are glandular-pubescent, but with the hairs much longer (glandular-villous rather than glandular-puberulent).

This plant occupies habitats similar to those of var. *obtusifolium* but it is much less frequently encountered. Mostly in the piedmont, North Carolina to Georgia. Summer and autumn.

5. *Gnaphalium spicatum* Lam., Encyc. 2: 757 (1786).

Biennial or annual, with conspicuous basal rosettes, and usually several decumbent flowering branches, 1-5 dm. high, from the base. Flowering stems simple or sparingly branched, the heads in crowded spicate glomerules. Stems and lower leaf surfaces conspicuosuly silvery-pannose, the upper leaf surfaces bright dark green, sparingly clothed with a floccose pubescence or glabrate, the surfaces proper lustrous and appearing lustrous even through the sparse pubescence. Rosette and lower cauline leaves semi-succulent, spatulate to oblanceolate, their apices rounded to obtuse, sometimes mucronate. Leaf margins entire or wavy, revolute. Cauline leaves remote, gradually diminishing in size upward into the bracteal leaves of the inflorescence. Heads short oblong-cylindrical, about 3 mm. in length, the involucres glabrous. Phyllaries yellowish-green, or purplish when young, the outer becoming straw-color and scarious, the inner with a straw-color and scarious base which tapers upward and then widens into a dirty-brown, hyaline, oval tip; below this tip white-hyaline-margined. The outer phyllaries ovate, obtuse to acute, the inner linear-oblong, rounded to obtuse.

Gnaphalium spicatum has not been reported for the range of Small's Manual (1933). It is known to occur in weedy places at Wilmington, North Carolina, and it is common as a weed in and around Tallahassee, Florida, thence westward to Pensacola, Florida.

6. *Gnaphalium purpureum* L., Sp. Pl. 854 (1753).

Biennial or annual, with basal rosettes, commonly with a single flowering stem, or often with several decumbent flowering branches from the base. Flowering stems simple or sparingly branched, 0.5-5 dm. high, the heads crowded in spicate glomerules. Stems and lower leaf surfaces silvery-pannose or lanate, the upper leaf surfaces moderately clothed with a flocculose pubescence, dull gray-green. Rosette and cauline leaves spatulate or oblanceolate, their tips rounded to obtuse and mostly mucronate. Leaf margins entire, not revolute. Cauline leaves remote, gradually diminishing in size upward into the bracteal leaves of the inflorescence. Heads 3-5 mm. high, the bases of the involucres enmeshed in a woolly tomentum. Texture and color of phyllaries as in *G. spicatum.* Outer phyllaries ovate, short-acute, the inner linear-oblong, very short-acuminate.

In weedly places such as lawns, gardens, vacant lots, old fields, and roadsides, throughout the range. Less common southward than *Gnaphalium falcatum* and *G. peregrinum.* Spring and early summer.

Among the relatively small number of specimens of *Gnaphalium purpureum* examined in this study, there are some which differ from the general concept with respect to certain of the characters of the involucres. The difference is evident even to the naked eye, but is more readily discernible at about ten magnifications. Whereas the outer phyllaries of what is taken to be typical *G. purpureum* are ovate, short-acute and the inner linear-oblong and very short acuminate, in the series of specimens in question the outer phyllaries are ovate and with much longer tapering tips, the inner linear-oblong and attenuate at their tips. The net effect of this difference is that the mature involucres of the latter have a fringed or brush-like appearance not characteristic of the typical. It is possible that this is a taxonomic difference which might have varietal significance but much more study would be required to resolve the problem. Attention is here called to it as a matter of interest and because the description of the involucres of *G. purpureum* given above is not apt for specimens of the atypical series. Specimens examined in this study which have involucres characteristized as above, as opposed to those described for the species, are as follows: VIRGINIA: dry sandy barrens south of Rifle Range, near Virginia Beach, Princess Anne Co., *Smith & Hodgdon,* PLANTAE EXSICCATAE GRAYANAE *887.* NORTH CAROLINA: in disturbed savanna, between Supply and the Waccamaw River, Brunswick Co., plants up to 12 dm. high, mostly 8-10 dm. high, *Godfrey 52372;* common locally along edge of shallow roadside ditch about 11 miles southwest of Jacksonville on Route 53 towards Burgaw, Pender Co., *Wilbur 4171.* SOUTH CAROLINA: abundant in a roadside ditch and in a low sandy fallow field, between Georgetown and Jamestown, *Godfrey & Boyce 50465.* FLORIDA: opposite Branford along the Suwannee River, Lafayette Co., May 20, 1941, *West & Arnold* (FLAS); banks of Santa Fe River, south of Hampton, Bradford Co., May 15, 1940, *West & Arnold* (FLAS); highway 40, 3½ miles east of Juniper Springs Road, Ocala National Forest, Marion Co., *Mather & Arnold M-264.*

7. *Gnaphalium calviceps* Fern., Rhodora 37: 449 (1935).

Annual, with inconspicuous, short-lived basal rosettes. Flowering stems 1-3 dm. high, simple, occasionally with several decumbent flowering stems from near the base, more commonly either with numerous erect flowering stems from near the base or with a single erect paniculately much branched flowering stem. Heads in spicate glomerules on the main axis or on a few- much-branched axis. Stems and both leaf surfaces uniformly cottony-lanate, dull gray-green throughout. Leaves numerous, fairly closely set, gradually diminishing in size upward; commonly falcate, the larger oblanceolate to linear-oblanceolate, the smaller nearly linear. The leaf tips narrow abruptly to an almost cylindrical mucro. Heads 3-3.5 mm. high, oblong-cylindric, only the very bases invested by a woolly tomentum, otherwise glabrous. Color and texture of phyllaries much as in *G. spicatum.* Outer phyllaries ovate, short-acute to acuminate, the inner linear-oblong, obtuse or broadly acute, often with a mucro.

In weedy places generally, mostly in sandy soil. Common in the coastal plain and infrequent in the piedmont of North Carolina and South Carolina. Late spring and summer.

Described from Virginia, later found to occur in the Carolinas, other specimens at hand which appear to be this species are: OKLAHOMA: old field, along the Poteau River, 8 miles east of Spiro, LeFlore Co., *Waterfall 8770* (GH). TEXAS: 4½ miles southwest of Argyle, Denton Co., *Cory 32047* (GH).

8. *Gnaphalium falcatum* Lam., Encyc. 2: 758 (1786).

Annual or winter annual, with inconspicuous, short-lived basal rosettes. Flowering stems 1-4 dm. tall, single, or more commonly with several to numerous decumbent flowering stems from near the base. Heads in spicate glomerules, the flowering branches simple to paniculate. Stems and both leaf surfaces about equally cottony-lanate, dull gray-green to silvery throughout. Leaves numerous, fairly closely set, the cauline not markedly diminishing in size upward—at least the lowermost bracteal leaves of the inflorescence commonly much similar in size to those lower down. Leaves often falcate, oblanceolate to linear-oblanceolate or linear, their tips abruptly narrowed to a short, almost cylindrical mucro. Heads 3-4 mm. high, oblong-cylindrical, almost wholly invested in a loose woolly covering when young but the upper halves sometimes becoming glabrous at maturity. Phyllaries mostly straw-color and scarious at maturity, the outer ovate, acute, the inner linear-oblong, their tips rounded to obtuse, few of them mucronate.

In sandy soil, weedy places generally, southeasternmost North Carolina to Florida, westward to Louisiana and Tennessee. Spring and early summer.

Gnaphalium falcatum and *G. calviceps* are closely similar. Possibly they should be treated as geographical varieties.

9. *Gnaphalium peregrinum* Fern., Rhodora 45: 479 (1943).
G. spathulatum Lam., not *G. spatulatum* Burm. f.

Annual or winter annual, with inconspicuous, short-lived basal rosettes. Flowering stems 1-5 dm. tall, single, or more commonly with several decumbent flowering stems from near the base. Heads in spicate glomerules, the flowering branches simple to somewhat paniculate. Stems rather densely clothed with a woolly tomentum, the leaf surfaces with a very loose woolly covering, that of the upper surfaces sparser than that of the lower. Plants dull olive-gray-green throughout. Leaves relatively remote, the cauline not markedly diminishing in size upward—at least the lowermost bracteal leaves of the inflorescence commonly much similar in size to those lower down. Leaves broadly oblanceolate to spatulate throughout, their tips broadly rounded to obtuse and with a small flat mucro. Leaf margins entire to finely and irregularly wavy. Heads about 4 mm. high, oblong, about ⅔ invested in a dense wool. Phyllaries straw-color and scarious at maturity, the outer ovate-lanceolate or lanceolate, long-acute, the inner linear-oblong and with rounded to short-acuminate tips.

In sandy or clayey soils, weedy places generally. Coastal plain, or less commonly piedmont, North Carolina to Louisiana. Spring and early summer.

I should like to state emphatically in regard to the members of the section GAMOCHAETA with which we are here concerned (*Gnaphalium spicatum, G. purpureum, G. calviceps, G. falcatum,* and *G. peregrinum*) that to characterize them in word descriptions is vastly more difficult than to distinguish between them by sight, particularly in the fresh condition. I am reminded of an experience I had one day when I encountered an uneducated negro "yard man" weeding a flower bed. After I had asked him whether I might take samples of the rabbit-tobacco weeds which he was pulling, he volunteered the information that there were four different kinds of rabbit-tobacco in that flower bed. I asked then how he could tell the difference between the kinds and he replied, "I dunno, suh, you just looks at 'em and sees the difference." He then agreed that as he weeded, he would sort them into four piles of the four kinds. This he readily did without help from me and in my judgment he did it without erring. Unquestionably I am unable to devise keys or descriptions which would enable a professional taxonomic botanist to do as well with herbarium material.

We see much when we look at a plant, or when we compare or contrast two similar ones, which it is not possible to portray characteristic by characteristic, either in technical or non-technical terms. This, I fear, not infrequently accounts for the remarkable difference in interpretation of closely related plants by different investigators. And it is the more likely to be true if one of them deals almost exclusively with herbarium material and the other is acquainted with the living plants.

LITERATURE CITED

FERNALD, M. L.

1935. Midsummer vascular plants of southeastern Virginia. *Rhodora* 37 : 449-450.

1943. Virginian botanizing under restrictions. *Rhodora* 45 : 478-479.

1950. Gray's Manual of Botany. Ed. 8. American Book Company. pp. 1463-1465.

GLEASON, H. A.

1952. New Britton and Brown Illustrated Flora. New York Botanical Garden. Vol. 3 : pp. 480-482.

SMALL, J. K.

1933. Manual of the Southeastern Flora. Univ. of North Carolina Press. pp. 1402-1403.

Quart. Journ. Fla. Acad. Sci., 21(2), 1958.

EXTENSION OF DISTRIBUTION OF *RUPPIA MARITIMA* VAR. *OBLIQUA* (SCHUR.) ASCHERS. AND GRAEBN.

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Very little taxonomic work has been done on the varieties of *Ruppia maritima.* One thorough work was done by Fernald and Wiegand (1914) on this species in eastern North America in which 10 varieties were treated as to distribution and taxonomy. They came to the opinion, after a study of many collections, that the American treatment of these plants had been much too conservative. They firmly believed that the described varieties of *Ruppia maritima* were natural taxonomic forms. Gleason (1952) intimated that many of the described varieties are ecological variants.

Ruppia maritima has been found in various locations around the central Gulf coast of Florida by the author. These plants were found in sterile condition until April and May, 1958, when they were in flowering state. In this condition it was possible to make a determination to variety. The varietal characteristics of *R. maritima* var. *obliqua* are: carpels ovoid, slightly oblique but not strongly eccentric or curved, bluntish or not tapering to a conspicuous beak; peduncles in maturity 1.5-6 cm. long, rarely spiraling; podogynes 0.6-2.5 cm. long.

Ruppia maritima var. *obliqua* was listed from the Magdalen Islands and Prince Edward Island by Fernald and Wiegand (1914) who also said that these two localities were the only American records for this variety. Fernald (1950) recorded it from Newfoundland to Rimouski Co., Quebec, south to Maine.

This variety was found in Crystal Bay in Citrus Co., on Cats Point Bank, Boca Ciega Bay, and in Upper Tampa Bay and Old Tampa Bay, Pinellas Co., Florida.

This constitutes an extreme discontinuous range of distribution. No explanation is offered if this is actually the distribution range. However, it is most probable that owing to the paucity of work done on the varieties of *Ruppia maritima* to date, the range of this variety may be much more widespread than has hitherto been reported.

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[1] Contribution No. 9 from the Fla. State Board of Conservation Marine Laboratory, St. Petersburg, Florida.

Sincere appreciation is accorded to Conservation Agent E. R. O'Berry who aided in the Crystal Bay, Citrus Co., Florida, collection.

LITERATURE CITED

FERNALD, M. L.

1950. Gray's Manual of Botany. 8th ed., American Book Co., New York. pp. 80-81.

FERNALD, M. L., and WIEGAND, K. M.

1914. The genus *Ruppia* in eastern North America. *Rhodora.* 16 : 119-127.

GLEASON, H. A.

1952. The new Britton and Brown Illustrated Flora of the Northeastern United States and adjacent Canada. New York Botanical Gard., New York. p. 84.

JELLIED CONDITION IN *PARALICHTHYS SQUAMILENTUS* FROM THE GULF OF MEXICO

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As little is known about the flounder, *Paralichthys squamilentus* Jordan and Gilbert, and its potentiality as a commercially important species has been suggested by Ginsburg (1952), it was thought worthwhile to report the following notes on its occurrance and indications of its periodic poor quality for commercial purposes.

Fishermen from Gasparilla Fisheries at Placida, Florida, called the writer's attention to a catch of their flounders that were in an unusual condition prohibiting their sale. The fish had been gutted (including gills) and iced in the usual manner but had "rotted" quickly and started "slipping out of their skins" by the time they were brought to port—a period of about three days.

We examined six of these fish and found them to be *Paralichthys squamilentus.* They had been caught January 1, 1957, off Appalachicola in 62 fathoms, in a large shrimp trawl. They ranged from 260 to 346 mm. in standard length; dorsal fin counts ranged from 74 to 80, anal from 59 to 62, pectoral 12 in all cases. They were deep bodied (depth = 45.1 to 49.6% of standard length) and dusky on the blind side. The fishermen who called our attention to this catch reported that in the latter part of January, 1956, great quantities of this same type of flounder were taken in the same area. The fish of the 1956 catch were not gutted and all were "rotten" by the time they reached port. Therefore, in the 1957 catch when the fish were located again in large numbers, only a small sample (24) was brought in and these were gutted soon after they were caught.

The condition of the six fish that we examined in the 1957 catch was as follows: The flesh was opalescent, soft and watery. The skin lifted easily away from the flesh. There was no bad odor to the fish. A similar condition has been reported by Templeman & Andrews (1956) for another species of flatfish, the American Plaice, *Hippoglossoides platessoides* (Frabricus), caught in commercial quantities in the Newfoundland area. As many as 40% of these fishes in a single catch were affected and had to be discarded. It has been postulated by Templeman & Andrews that this "jellied" condition is one of protein impoverishment due to failure of fish living in very cold water to recover their body protein loss after spawning and absorbing water to replace it. They found no accumulation of proteolytic end products such as would be expected if the sporozoan parasite *Chloromyxum* were the causal agent. Species of *Chloromyxum* and related sporozoan parasites have been associated with a "jellied" condition in swordfish, tuna, bass and a number of other Pacific fishes. (Arai and Matsumoto 1953, Matsumoto 1954, McGonigle and Leim 1937, and Willis 1949.) Unfortunately, because the examples we examined had been gutted we could not examine the state of the gonads for evidences of whether spawning might have taken place recent to their catch. Also we did not make any examination for sporozoan parasites.

The Placida fishermen who have had many years experience shrimp trawling on the east coast of the Gulf of Mexico had never seen or heard of this condition before, aside from the two catches described here. They also reported these were the only two times they remember catching this species of flounder. This apparently is the first time an extensive "jellied" condition has been reported from fishes in the Gulf of Mexico and is the only known case where 100% of the individuals of the affected species caught showed the unusual condition.

LITERATURE CITED

ARAI, YARO, and MATSUMOTO, KOICHI

1953. On a new sporozoa, *Hexacapula neothunni* gen. et sp. nov., from the muscle of the Yellowfin Tuna, *Neothunnus macropterus*. Bull. Jap. Soc. Sci. Fisher. 18(7): 1-6.

GINSBURG, ISAAC

1952. Flounders of the genus *Paralichthys* and related genera in American waters. U. S. Fish and Wildlife Service, Fishery Bull., 52(71): 267-351.

MATSUMOTO, KOICHI

1954. On the two new Myxosporidia (*Chloromysum musculoliquefaciens*) and (*Neochloromyxum cruciformum*) from the jellied muscle of swordfish (*Xiphias gladius*) and common Japanese Sea Bass (*Lateobrax japonicus*). *Bull. Jap. Soc. Sci. Fisheries* 20 : 469-479.

McGONIGLE, R. H., and LEIM, A. H.

1937. Jellied Swordfish. Progress Report. Atlantic Biol. Sta. Atlantic Fish. Exptl. Sta. (19): 3-5.

TEMPLEMAN, WILFRED, and ANDREWS, GERTRUDE L.

1956. Jellied condition in the American Plaice *Hippoglossoides platessoides* (Fabricius). *J. Fisheries Res. Bd. Canada* 13 : 149-182.

WILLIS, A. G.

1949. On the vegetative forms and life history of *Chloromyxum thyrsites* Gilchrist and its doubtful systematic position. *Australian J. Sci. Res., Series B, Biological Sciences* 2 : 379-398.

RESEARCH NOTE

ADDITIONS TO THE FISHES OF CEDAR KEY, FLORIDA, AND A LIST OF GULF OF MEXICO CARANGIDAE

Two species are added to the list of fishes known from the vicinity of Cedar Key, Florida (Reid, 1954, Bull. Mar. Sci. Gulf & Carib., 4(1): 1-94. Kilby, 1955, Tulane Stud. Zool., 2(8) : 175-247. Caldwell, 1954, Quart. Jour. Fla. Acad Sci., 17(3): 182-184. Caldwell, 1955, *Ibid.*, 18(1): 48. Caldwell, 1957, *Ibid.*, 20(2): 126-128. Berry, 1958, *Ibid.*, (1957), 20(4): 232.)

Seriola zonata (Mitchill). Banded rudderfish. A specimen, 165 mm. in standard length, was caught 8 miles off Cedar Key on May 24, 1958, by Dr. R. E. Page and loaned to me by Dr. E. Lowe Pierce, both of the University of Florida.

Following the work of Ginsburg (1952, Pub. Inst. Mar. Sci., 2(2): 43-117) and my own investigations, the following 26 species of the family Carangidae are known to have been taken from the Gulf of Mexico, with the 11 species that have now been recorded from the Cedar Key area prefixed by an asterisk: **Oligoplites saurus* (Bloch and Schneider), *Naucrates ductor* (Linnaeus), *Elagatis bipinnulatus* (Quoy and Gaimard), **Seriola zonata* (Mitchill), **Seriola dumerili* (Risso), *Seriola fasciata* (Bloch), *Seriola falcata* Cuvier, **Trachinotus carolinus* (Linnaeus), **Trachinotus falcatus* (Linnaeus), *Trachinotus glaucus* (Bloch), *(*Chloroscombrus chrysurus* (Linnaeus), **Caranx crysos* (Mitchill), **Caranx ruber* (Bloch), *Caranx bartholomaei* Cuvier, *Caranx latus* Agassiz, **Caranx hippos* (Linnaeus), *Caranx lugubris* Poey, *Hemicaranx amblyrhynchus* (Cuvier), *Hemicaranx fasciatus* (Cuvier), *Uraspis heidi* Fowler, *Selar crumenophthalmus* (Bloch), *Decapterus punctatus* (Agassiz), *Trachurus lathami* Nichols, **Vomer setapinnis* (Mitchill), **Selene vomer* (Linnaeus), *Alectis crinitus* (Mitchill).

Lagocephalus laevigatus (Linnaeus). Smooth puffer. A specimen, 310 mm. in standard length, was caught by Dr. Pierce off Cedar Key in June, 1958, and was brought to my attention by Dr. Daniel M. Cohen of the University of Florida. Schultz (1949, Proc. U. S. Nat. Mus., 99(3235): 197) considered *L. pachycephalus* (Ranzani), which has also been recorded from the northern Gulf of Mexico, to be a synonym of *L. laevigatus*.

In his list of Florida fishes Briggs (1958, Bull. Fla. State Mus., Biol. Sci., 2(8): 223-318) indicated that about 550 species of shore fishes occur on the west coast of Florida from the southern Florida Keys to Alabama. Approximately 135 of these have not been reported north of the Florida Keys; therefore, about 415 species of shore fishes have been recorded from West Florida north of the Florida Keys; to date, 149 species from 66 families have been recorded from the Cedar Key vicinity.—FREDERICK H. BERRY, U. S. Fish and Wildlife Service, Brunswick, Georgia.

Quart. Journ. Fla. Acad. Sci., 21(2), 1958.

INSTRUCTIONS FOR AUTHORS

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Vol. 21 September, 1958 No. 3

Contents

Kral and Godfrey—Synopsis of the Florida Species of *Cacalia* 193
Riemer—Giant Toads of Florida 207
Elder, Argus, and Ray—Antibody Response to Rat Gastric Mucosa 212
Olson and Olson—Luigi Ferdinando Marsigli, the Lost Father of Oceanography 227
Gehringer—Leptocephalus of the Atlantic Tarpon, *Megalops atlanticus* Valenciennes, from Offshore Waters 235
Bovee—Amebas of Warm Mineral Springs, Florida, Including *Cochliopodium papyrum* n. sp. 241
Auffenberg—A Small Fossil Herpetofauna from Barbuda, Leeward Islands, with the Description of a New Species of *Hyla* 248
Berry and Rathjen—A New Species of the Boarfish Genus *Antigonia* from the Western Atlantic 255
Sogandares-Bernal and Hutton—Studies on Helminth Parasites from the Coast of Florida. IV. Digenetic Trematodes of Marine Fishes of Tampa, Boca Ciega Bays, and the Gulf of Mexico 259
Arata—Notes on the Eggs and Young of *Gopherus polyphemus* (Daudin) 274
Shirley, Haines, Warnick, Wallace, and Davis—Effect of Stage of Gestation, Dietary Energy and Progesterone on the Succinoxidase of Swine Uteri 281
Caldwell—On the Status of the Atlantic Leatherback Turtle, *Dermochelys coriacea coriacea*, as a Visitant to Florida Nesting Beaches, with Natural History Notes 285

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THE QUARTERLY JOURNAL OF THE
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SYNOPSIS OF THE FLORIDA SPECIES OF *CACALIA* (Compositae)

R. Kral and R. K. Godfrey[1]
Northeast Louisiana State College and Florida State University

The genus *Cacalia* Linnaeus (*Mesadenia* Rafinesque) is represented in Florida by a small group of perennial herbs of which all species but one (*C. floridana*) occur in moist habitats such as marshes, bogs, swampy woodlands, floodplain woodlands, or poorly drained flatwoods. *C. floridana* inhabits well-drained, coarse sands of scrub oak-longleaf pine ridges and hills and the drier flatwoods. Little or no economic importance has been attributed to the genus, and no recent revision has been made of the taxa considered here.

There are differences of opinion among authors of the more recent floras as to the number of species of *Cacalia* occurring in Florida. Small (1933) lists seven, including *C. atriplicifolia* L. and *C. suaveolens* L., the latter species being treated by Small as *Synosma suaveolens* (L.) Britton. Fernald (1950) includes Florida in the range of both of the above-named species. Gleason (1952) includes Florida in the range of *C. suaveolens* but gives Georgia as the southernmost limit for *C. atriplicifolia*. In preparation of this synopsis we have examined the Florida material deposited in the following herbaria: Gray Herbarium, New York Botanical Garden, U. S. National Herbarium, Duke University, the University of Florida, and the Florida State University. We have seen no specimens of either of the above-mentioned species in these collections. Neither have we seen plants of either species in our own recent

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[1] Expenses incurred in the field work contributing to this research were met with funds made available to the junior author by a grant from the National Science Foundation (G-2010). Assistance in the herbarium was made possible by a grant from the Research Council, Florida State University.

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explorations in Florida. It is possible that certain areas in western Florida, which harbor numerous plants principally of more northern distribution, may yet yield them. *C. suaveolens,* particularly, may be expected for Chapman (1897), who did much field work in western Florida, says of it: "Low ground, West Florida, and northward." The statement indicates that Chapman had a definite view on its occurrence specifically in western Florida; otherwise he might merely have stated "Florida, and northward," as he did in the case of *C. atriplicifolia.* In the absence of actual records, we have excluded both species from this synopsis. Earlier authors are in agreement as to the occurrence in Florida of the remaining taxa here treated.

This study was undertaken because of the difficulty we have had in identifying our specimens of *Cacalia* by using standard keys and descriptions. Moreover, misidentifications apparent on herbarium specimens examined by us have led us to think that other workers must have had similar difficulty. It is hoped that more comprehensive descriptions, newly constructed keys, and pertinent ecological information will help to clarify the problems.

HABIT

Field evidence indicates the following developmental habit for species of *Cacalia,* in general:

> Achenes are shed during the summer or fall and germinate to form rosettes in the winter or spring. The rosettes may either bear flowering stems during the succeeding season or overwinter again to produce flowering shoots the following season. The flowering plant itself may produce lateral offshoots which develop into overwintering rosettes. The latter usually become detached from the parent plant by disintegration of the connecting stolon. Flowering times are distinct for some of the species. *C. diversifolia* is the first of the species to flower in northern Florida, reaching anthesis by May. *C. floridana* begins to bloom nearly as early in peninsular Florida, flowering from the middle of May through July. In August and September *C. lanceolata* and var. *elliottii,* and *C. sulcata* reach anthesis, their period of bloom extending through the late autumn. In southern peninsular Florida, however, populations of *C. lanceolata* may bloom throughout the winter and spring.

Most authors describe the inflorescence as a corymb, thus indicating an indeterminate inflorescence. The inflorescence of *Cacalia* is determinate and should be considered a compound cyme.

AFFINITIES OF THE SPECIES

The Florida species of *Cacalia* comprise two morphological groups. Plants of one group have sulcate or angled stems, relatively broad leaves, and winged phyllaries. This group includes *C. diversifolia, C. floridana,* and *C. sulcata.* Plants of the other group have terete stems, narrow to broad leaves, wingless phyllaries, and glaucous to glaucescent lower leaf surfaces. This includes *C. lanceolata* var. *lanceolata* and *C. lanceolata* var. *elliottii.*

The primary criteria used to delimit species in most treatments of *Cacalia* involve the nature of the involucral bracts, leaf shape, the number of principal veins of the leaf blade, and the angulation (or lack of it) of the stem. The species descriptions have a paucity of information as to the general appearance and size of the plants, little or no reference to rosette leaves. The overall stature of the plants is significant. Features of the rosette leaves are of considerable value in making specific determinations. It is especially desirable for collectors, in cases where it is not practicable to preserve the whole plant, to record pertinent measurements, and especially to preserve basal rosettes. Most herbarium specimens which we have examined are of very limited value in helping to formulate species concepts.

We are inclined to the view that undue emphasis has been placed upon the so-called tuberous nature of the caudex of *Cacalia tuberosa* Nutt., a plant of midwestern United States. This character is evident, to varying degrees, in all of the Florida species and its prominence is largely dependent upon the time of collection of the specimen. *C. floridana, C. diversifolia,* and *C. lanceolata* all have conspicuously thickened caudices at certain stages of their development.

The taxonomic value of the number of the principal veins of the leaf in determining species has been overemphasized. For example, the basal leaves of *Cacalia floridana* may have from 3-7 (-9) principal veins, thus overlapping the extremes of venation occurring in *C. sulcata.* The number of principal veins in each of the species is dependent on the breadth of the leaf, a feature which varies widely within populations.

GENERIC DESCRIPTION

Perennial, caulescent, herbs, forming rosettes and stout, erect, or inclined caudices. Leaves alternate; rosette and basal cauline leaves petioled, the upper cauline leaves mostly sessile; cauline leaves gradually diminishing in size upward on the stem. Leaf margins entire, crenate, undulate, toothed, or lobed. Inflorescence a large compound cyme. Involucre cylindric or campanulate, oi five subequal, pale green to yellowish-white, winged or wingless phyllaries. Heads discoid, of five to many bisexual, fertile flowers. Corollas yellowish, cream-colored, or lavender, the lobes recurved, linear, longer than the tubular throat. Pappus of numerous soft capillary bristles. Achene brown to mahogany-colored, fusiform to cylindric, variously ribbed.

KEY TO THE SPECIES

1. Phyllaries winged; stem angled or grooved.
    2. Blades of rosette and lower cauline leaves truncate-ovate to cordate-ovate, angulate-lobed to angulate-dentate, corollas, lavender . . . . 1. *C. diversifolia*
    2. Blades of rosette and lower cauline leaves elliptic to ovate, entire, sinuate-crenate, crenate, or undulate-dentate; corollas yellowish, or yellow with green, tan, or maroon tints.
        3. The rosette leaves with petioles less than one-half the total length of the leaf; rosette and lower cauline leaves crenate, sinuate, or crenate-dentate; plants of coarse sands of scrub oak-pine sand ridges and hills, drier pine-palmetto flatwoods, and sandy old fields; flowering in late spring or early summer . . . 2 *C. floridana*
        3. The rosette leaves with petioles more than one half the total length of the leaf; rosette and lower cauline leaves angulate-dentate, undulate-dentate, or occasionally entire; plants of wet pine flatwoods, bogs stream banks and river bottoms; flowering in late summer or fall . . . . 3. *C. sulcata*
1. Phyllaries not winged; stem terete or very slightly ridged above.
    4. Rosette and lower cauline leaves linear to lanceolate, entire to distantly toothed, green to slightly glaucous beneath; plants 0.5-1.5 m tall . . . . 4. *C. lanceolata* var. *lanceolata*
    4. Rosette and lower cauline leaves ovate to ovate-lanceolate, entire or sinuate (very rarely distantly toothed), evidently but often not strongly glaucous beneath; plants 1.5-2.5 m tall . . 5. *C. lanceolata* var. *elliottii*

TREATMENT OF THE SPECIES

1. *Cacalia diversifolia* T. & G., Fl. N. Am. 2:435. 1886. Fig. 1.
Mesadenia diversifolia (T. & G.) Greene, Pittonia 3: 182. 1897.
M. difformis Small, Fl. SE U. S. 1301. 1903.

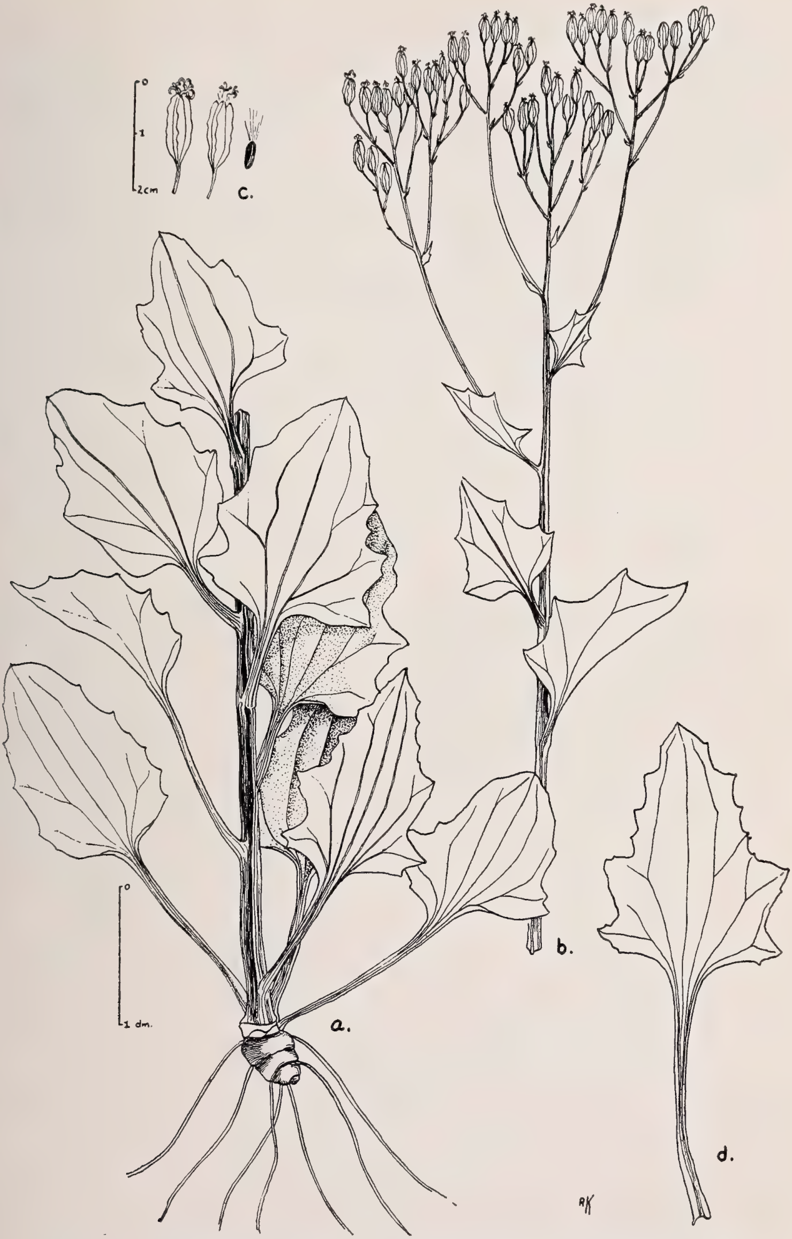


Figure 1. *Cacalia diversifolia.* a. Basal portion of stem and caudex. b. Summit of stem with inflorescence. c. Heads and achene. d. A rosette leaf.

Plant 7.0-15.0 dm tall, from a short, stout caudex. Stem purplish or pale, not glaucous, angled or somewhat sulcate at the base, greenish and striate-angled above. Leaves green on both sides, the rosette and lowermost cauline leaves 15-30 cm long, the expanded portion of the blade comprising no more than one-third the total leaf length; blades ovate-deltoid to elliptic, or occasionally orbicular, the margins repand-toothed, sinuate, or entire; blades 4-5-veined, their bases truncate, rounded, or obtuse to slightly cordate, thence closely decurrent to the petiolar base. Upper cauline leaves short-petiolate to sessile, appearing hastate or even trifid because of the larger pair of teeth or lobes at the base, remotely but prominently toothed; bases of the blades broadly cuneate to truncate, abruptly contracted to the petiole (if the petiole is present) and decurrent to the petiolar base. Cyme narrowly convex to flat-topped. Heads narrowly campanulate to cylindric. Phyllaries about 10 mm long, yellowish-green to greenish-white, linear-lanceolate and with a winged midrib, their margins scarious. Corollas pale or bright lavender at anthesis, turning yellowish-brown. Achenes fusiform, 4-5 mm long, dark brown, inconspicuously ribbed and somewhat flattened.

Northwestern peninsular and western Florida, southwestern Georgia. River swamps, bottomland alluvium, and mesic woodlands on stream banks. Florida specimens examined from Levy, Calhoun, Jackson, and Washington Counties.

Inclusion in the manuals of *Cacalia atriplicifolia* for Florida is probably based upon misidentifications of old collections of *C. diversifolia* although the angulate stem and green rather than glaucous lower leaf surfaces of the latter would indicate a different affinity. *C. diversifolia* is somewhat similar to *C. sulcata,* a plant of similar habitats and overlapping range. The best means of distinguishing between the two is the truncate or rounded base of the leaf blades of *C. diversifolia* in contrast to the acute or narrowly rounded bases of the blades of *C. sulcata.* The former tends to have a broader leaf with a more toothed or lobed margin than does the latter.

Chapman (1897) was the first to give a definite locality for this species: "Muddy banks of the Chipola River, Marianna, West Florida." It is, incidentally, well represented at this locality at present. We have no knowledge of its occurrence between the Chipola River and the Gulf Hammock area of northwestern peninsular Florida, Levy County, about 200 miles distant. There it thrives on moist stream banks and in hammock thickets. Although plants of the Levy County population are indistinguishable from those of the Chipola River area, they bloom much later in the year. Plants in anthesis have been collected in the Gulf Hammock during

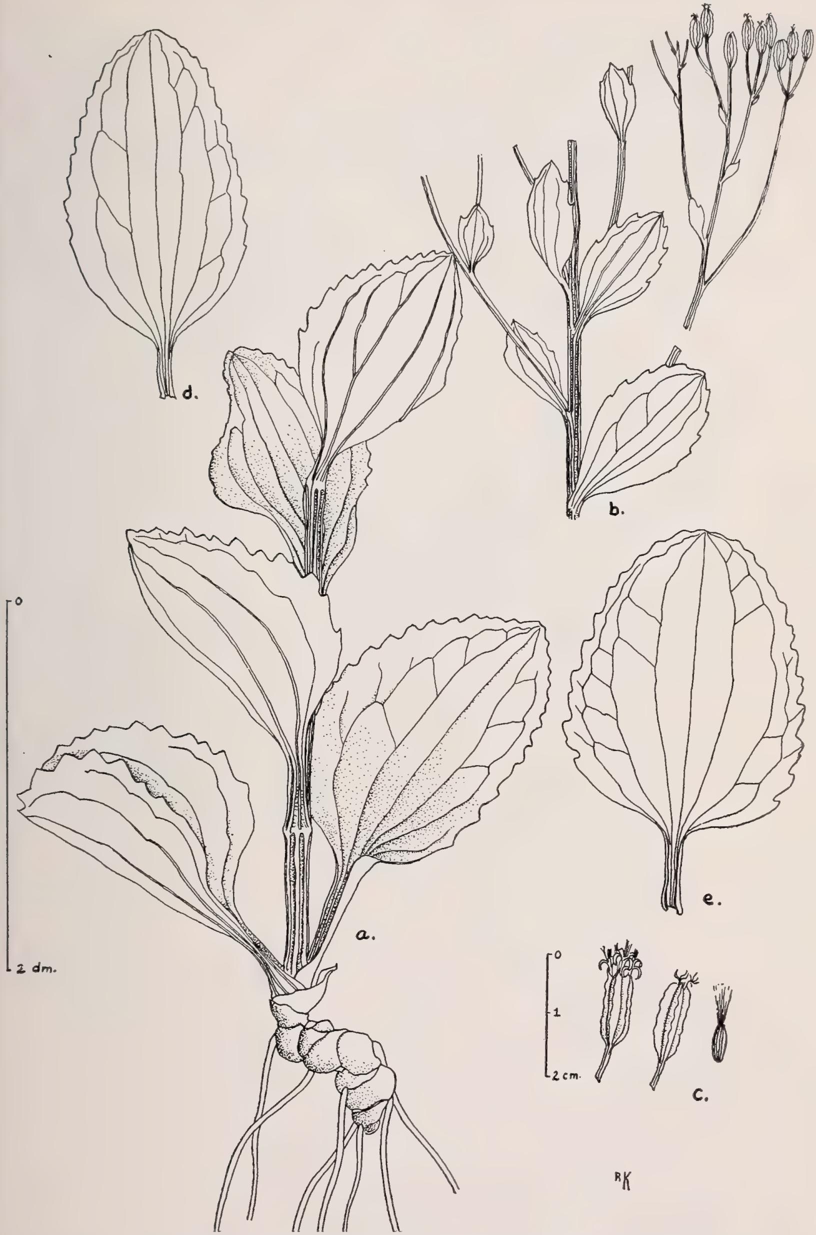


Figure 2. *Cacalia floridana.* a. Basal portion of stem and caudex. b. An upper portion of the stem and a small portion of the inflorescence. c. Heads and achene. d. A lower stem leaf. e. A rosette leaf.

the first week in August while those in the Chipola River area were well past anthesis—the same year.

2. *Cacalia floridana* A. Gray, Proc. Amer. Acad. 19: 52. 1883. Fig. 2. *Mesadenia floridana* (A. Gray) Greene, Pittonia 3: 183. 1897.

Plant 4.0-15.0 dm tall, with a short, stout caudex bearing thickened roots. Stem not glaucous, deeply sulcate, 4-7 angled below to striate-angled above, the ridges purple or maroon to the summit of the stem. Leaves green on both sides, gradually reduced upward to the inflorescence, the rosette and basal cauline leaves 15-20 cm long, the expanded portion of the blade comprising one-third to one-half the total length of the leaf; blades ovate (-orbicular) to oblong-elliptic, 4-7-veined, margins entire, distantly denticulate or undulate to closely or distantly crenate or dentate, the apices of the crenations or dentations often mucronate; bases of the blades truncate, rounded, or broadly cuneate, abruptly contracting to the petiole, thence closely decurrent to the petiolar base. Upper cauline leaves sessile, elliptic to broadly lanceolate, entire, or sinuate. Cyme broad, flat-topped to slightly convex, diffuse to congested, the secondary rays of the cyme with scattered scale-like bracts. Heads narrowly campanulate to cylindric at anthesis. Phyllaries 10-14 mm long, linear-lanceolate, yellowish or greenish-white, winged and with broad scarious margins. Corollas yellowish or yellowish-tan, the lobes linear, recurved. Achenes 3-5 mm long, fusiform to columnar, conspicuously ribbed, terete.

Northeastern, and central peninsular Florida. Well-drained sands of pine-scrub oak sand ridges and hills, drier pine-palmetto flatwoods, sandy old fields, and roadsides. Florida specimens examined from Duval, Columbia, and Suwannee Counties southward to Highlands County.

3. *Cacalia sulcata* Fern., Bot. Gaz. 33: 157. 1902. Fig. 3. *Mesadenia sulcata* (Fern.) Small, Fl. SE U. S. 1301. 1903.

Plants 7.0-14.0 dm tall, with a stout, short to somewhat elongated, vertical or ascending caudex. Stem not glaucous, 4-7-angled and purplish-maroon below to greenish and striate-angled above. Leaves green on both surfaces, gradually reduced upward to the inflorescence. Rosette and basal cauline leaves 20-25 cm long, the lanceolate to ovate blades comprising less than one-half the total leaf length; bases of the blades narrowly acute to cuneate, thence decurrent as a narrow wing to the petiolar base; leaf margins entire to sinuate. Middle and upper cauline leaves ovate to narrowly lanceolate, 5-14 cm long, sessile, distinctly toothed, shallowly or deeply so. Cymes diffuse to congested, the secondary rays of the cyme with scattered scale-like bracts. Heads narrowly campanulate to cylindric. Phyllaries 7-10 mm long, yellowish or greenish-white, winged and with broad scarious margins. Corolla lobes yellowish,

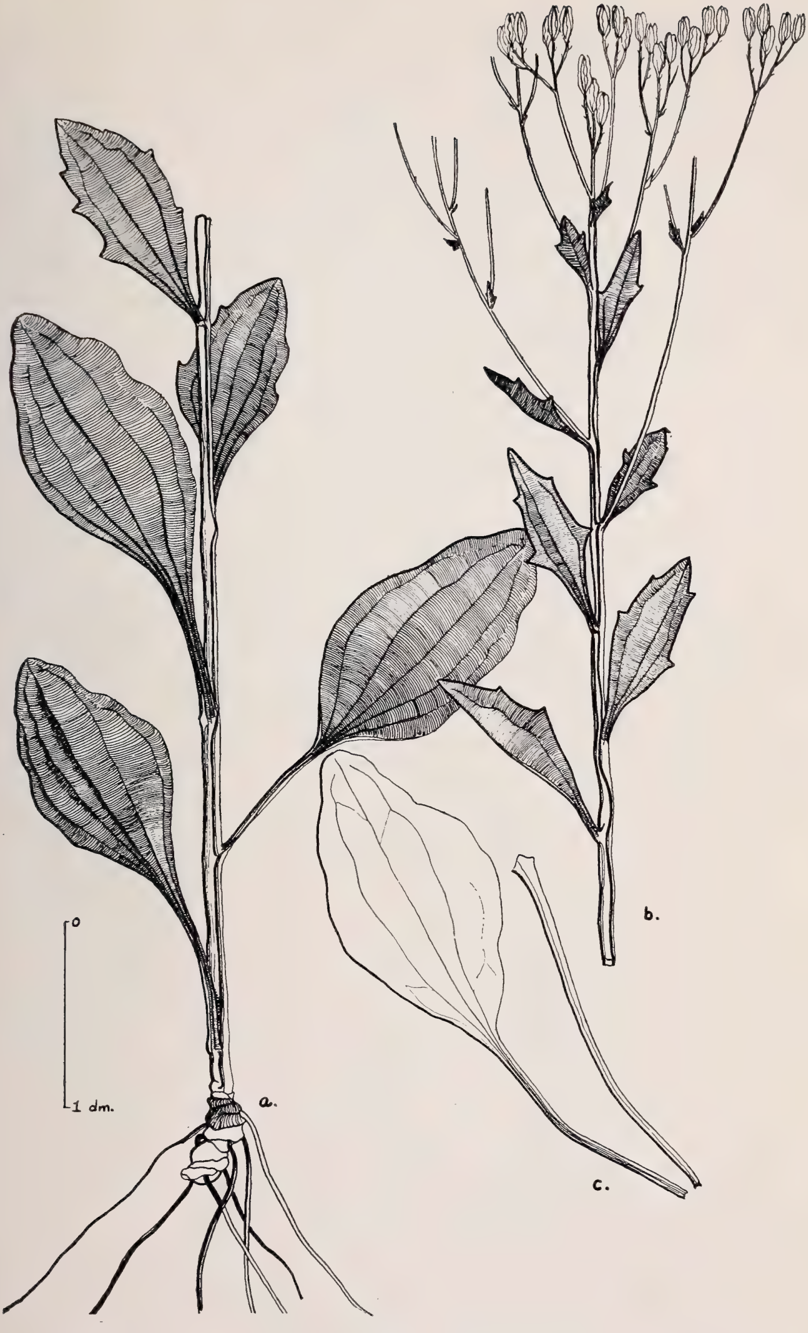


Figure 3. *Cacalia sulcata.* a. Basal portion of stem and caudex. b. Summit of stem with portion of inflorescence. c. A rosette leaf.

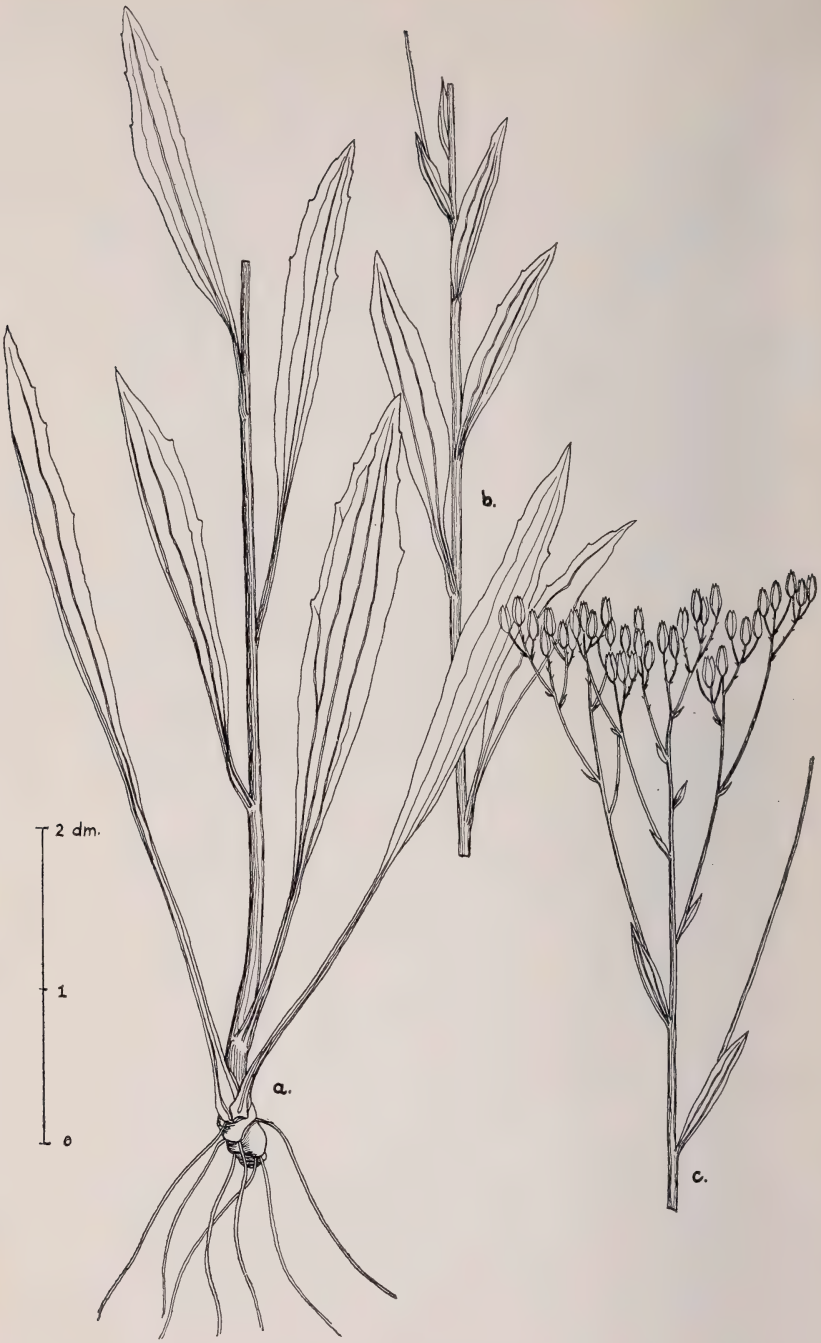


Figure 4. *Cacalia lanceolata* var. *lanceolata*. a. Basel portion of stem and caudex. b. A mid-portion of stem. c. Portion of the inflorescence.

linear and recurved. Pappus 4 mm long, white. Achenes 4 mm long, brown, fusiform, conspicuously ribbed.

Northwestern Florida, southern Alabama, and southwestern Georgia. Peaty borders of swamps, sphagnous bogs, and wet woodlands. Florida specimens examined are from Leon County westward.

Plants of this species may possibly be mistaken for those of *Cacalia diversifolia* or *C. floridana*. *C. diversifolia* most commonly occurs in bottomlands along rivers and smaller streams or in moist to wet hammocks, often in shallow water during flood stages. *C. sulcata* occurs more commonly in acid bogs or swamps. As compared to *C. floridana,* the basal and cauline leaves of *C. sulcata* are narrower and the leaf blades narrow more gradually to the petiole. The leaf margins of the latter range from entire to sinuate or distantly and shallowly toothed; those of the former range from sinuate to predominantly crenate. The petioles of the rosette leaves of *C. floridana* normally do not exceed one-half the total leaf length; those of *C. sulcata* are rarely less than one-half the total leaf length. Insofar as we know, the ranges of the two do not overlap and in general the habitats are distinctly different.

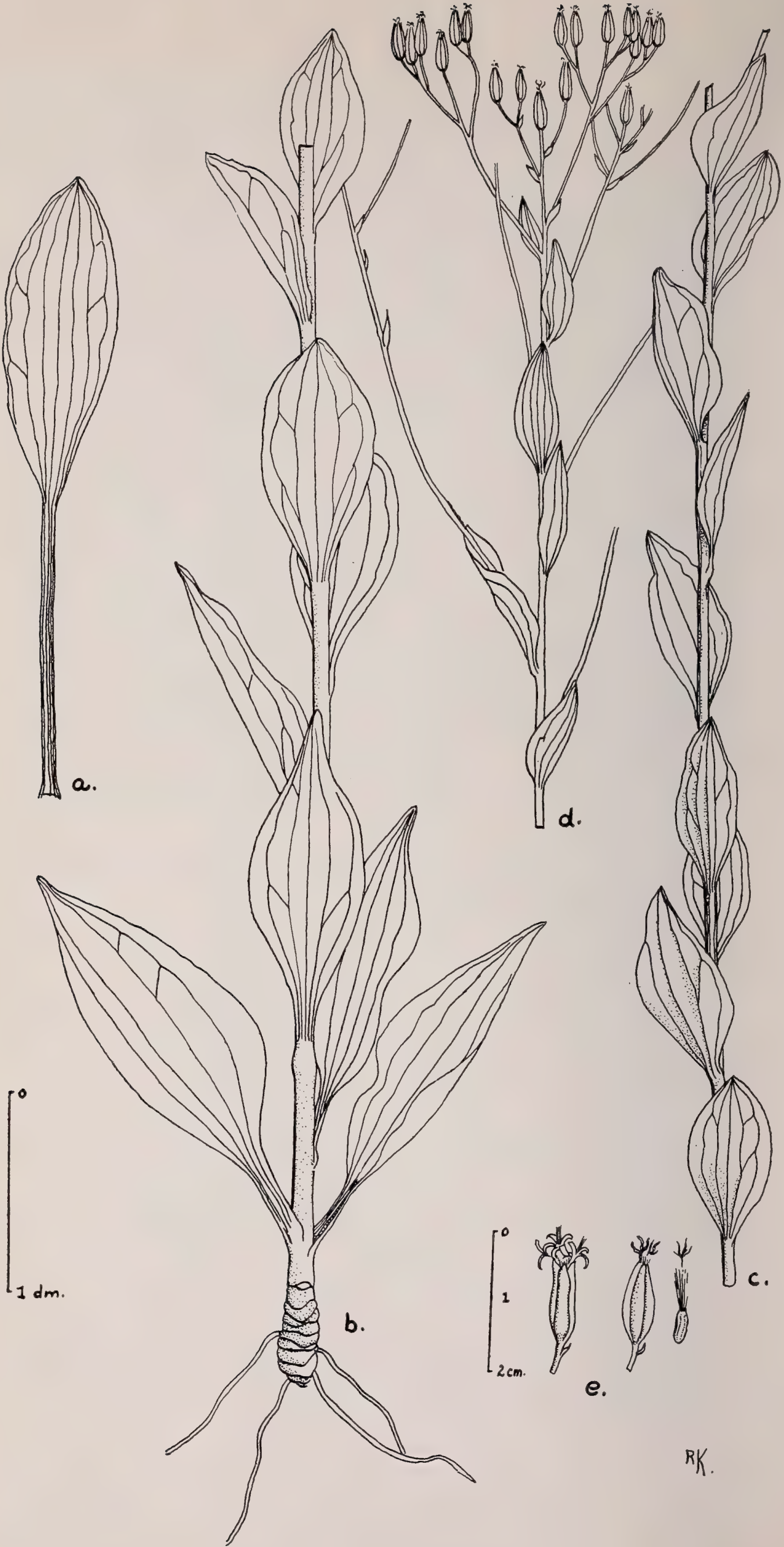
4. *Cacalia lanceolata* Nutt., Gen. 2: 138. 1818. (var. lanceolata) Fig. 4.

Mesadenia lanceolata (Nutt.) Raf., New. Fl. N. A., 4: 79. 1838, and ex Greene, Pittonia 3: 183. 1897.

M. angustifolia Rydb., Bull. Torrey Bot. Club 51: 378. 1924.

Plant 5.0-15.0 dm tall, with a fleshy, short to somewhat elongate, fleshy-rooted caudex. Stem glabrous or slightly glaucous, purplish or pale green below, pale green above, terete. Leaves dark green above, paler or glaucous beneath. Rosette or lowermost cauline leaves 15-30 (-40) cm long, linear to linear-lanceolate, or narrowly elliptic, 3-5-veined, their margins entire to sinuate, coarsely toothed, or distantly denticulate, long-petioled. Middle and upper cauline leaves with much the same outline as the lower but the petioles much reduced or absent. Cyme convex to flat-topped and with numerous scale-like bracts on the secondary branches. Heads narrowly to broadly cylindric at anthesis. Phyllaries 8-11 mm long, linear-lanceolate, greenish or yellowish-white, wingless. Corollas pale yellow to cream with tinges of lavender. Pappus 6 mm long, white. Achenes 3-4 mm long, columnar to broadly fusiform, dark brown, ribbed.

Eastern North Carolina southward to southern Florida, westward to southeastern Texas. Savannas, wet pine flatwoods, ditches, and wet sandy woodlands. Specimens examined from more or less throughout Florida.


a.
b.
c.
d.
e.
0
1 dm.
0
1
2cm.
RK.

5. *Cacalia lanceolata* Nutt. var. elliottii (Shinners) Kral & Godfrey, *comb. nov.* Fig. 5.

C. elliottii (Harper) Shinners, Field and Laboratory 18: 80. 1950.

Mesadenia elliottii Harper, Torreya 5: 184. 1905.

Similar to *Cacalia lanceolata* var. *lanceolata.* Plants taller, 15-25 dm tall. Stems glaucous and more leafy to the infloresence. Leaf blades ovate (-orbicular) to broadly elliptic, those of the rosettes and lower stems 15-30 cm long, dark green above, paler and glaucous to glaucescent below.

Cacalia lanceolata var. *elliottii* is much less common than var. *lanceolata.* Plants exhibiting the extremes of the range of stature and leaf characters are easily distinguished but in some populations they appear to intergrade. In the wet pine flatwoods and open hardwood hammocks in the vicinity of Newport, Wakulla County, Florida, there are populations of these plants in which the leaves range from linear to elliptic-lanceolate to broadly ovate, the leaf margins from entire to coarsely toothed. The tendency is for the broader-leaved individuals to be more glaucous, have greater stature, more leafy stems, and entire leaves. Moreover, the broader-leaved plants have shorter-petioled rosette and lower cauline leaves than do the narrow-leaved plants. Ledin (Quarterly Jour. Fla. Acad. Sci. 14: 166-167, 1951) states with reference to *Mesadenia elliottii:* "Plants resembling *M. lanceolata* but the leaves are ovate or oval in outline, entire or slightly undulate. Probably not a good species but should rate at least a varietal rank. Plants can be found that grade into *M. lanceolata.* In low places with the same habitat as *M. lanceolata.*" Determination of specimens of this taxon (then treated as *Cacalia ovata* Walt.) of Chapman (presumably in his handwriting) are of interest. The names on the specimen sheets indicate some vacillation and indicate an inclination to consider the broader-leaved plants as a variety of *C. lanceolata.*

References

CHAPMAN, A. W.
1887. Flora of the Southern United States. Ed. 3. American Book Company, New York.

Figure 5. *Cacalia lanceolata* var. *elliottii.* a. A rosette leaf. b. Basal portion of stem and caudex. c. A mid-portion of stem. d. Summit of stem and portion of the inflorescence. e. Heads and achene.

De CANDOLLE, A.
1837. Prodromus 6: 328-330. Treuttei & Wurtz, Paris.

FERNALD, M. L.
1950. Gray's Manual of Botany. Ed. 8. American Book Company, New York.

GLEASON, H. A.
1952. New Britton and Brown Illustrated Flora. New York Botanical Garden, New York.

GRAY, A.
1886. Synoptical Flora of North America. Vol. I, part II. Ivison, Blakeman, Taylor, and Company, New York.

HARPER, R. M.
1905. "*Mesadenia lanceolata* and its allies." Torreya 5: 182-185.

RYDBERG, P. A.
1924. "Some Senecioid genera." Bull. Torrey Bot. Club 51: 369-378.

SHINNERS, L. H.
1950. "The Texas species of *Cacalia*." Field and Laboratory 18: 80-83.

SMALL, J. K.
1933. Manual of the Southeastern Flora. University of North Carolina Press, Chapel Hill.

Quart. Journ. Fla. Acad. Sci. (1958), 21(3), 1959.

GIANT TOADS OF FLORIDA

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Repetitiously there appear in the public press of this state startling accounts of monstrous toads which threaten housewives in their backyards, seize dogs by the head and hang on with a death-resulting grip, or attack and kill with their virulent poison the innocent neighborhood cats.

An Associated Press release has been widely printed during 1958 which renews these tales. In a variety of versions it has appeared in most of the newspapers of Florida, and informants report its presence on the air or in the press as far away as Texas and Pennsylvania.

Ordinarily the offender is described in terms similar to these: "The poisonous [sic]reptile is warty, yellow-brown and about five times as large as an average bullfrog"! On the infrequent occasions when a particular kind of creature is accused of being responsible for these untoadlike actions, it is invariably singled out as *Bufo marinus.* However, the validity of these accusations may be questioned since it is possible that several large *Bufo* may occur in Florida.

The following paragraphs are presented with the idea of summarizing the history of large toads in Florida, and of correcting and clarifying some of the details of that story.

Bufo marinus

Prior to June 1936, R. N. Lobdell of the University of Florida Agricultural Experiment Station, with the cooperation of the United States Bureau of Entomology, imported from Puerto Rico and released at Canal Point and at Belle Glade, Florida, about 200 individuals of this species. It was hoped that these toads would be useful in reducing the number of cutworms, click beetles, and other insect enemies of sugarcane (Lobdell, 1936). This is the first importation and intentional release in Florida of which I find record.

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[1] A contribution from The Florida State Museum and The Department of Biology.

Sometime prior to 1944 the United States Sugar Corporation introduced *Bufo marinus,* this time at Clewiston, Florida. The stock again was imported from Puerto Rico and with the hope of controlling sugarcane pests (Oliver, 1949). Clewiston, Belle Glade, and Canal Point are along the southern and eastern shores of Lake Okeechobee in southern Florida.

In recent years several Floridian dealers in imported animals have carried this species in stock. Along with other exotic forms which escaped through negligence or were intentionally released, *Bufo marinus* has been found in the Miami area where several of these importers are in business. Allen and Neill (1958) have reviewed many of these details in a sportsman's magazine, the organ of the Florida Game and Fresh Water Fish Commission.

Additional introductions are alleged to have been made at Pennsuco, 10 miles northwest of Miami, and on the west coast at the Bass Biological Laboratory at Englewood; however, I have been able to uncover no additional details.

Most authors consider these introductions unsuccessful. No further mention is made by the Agricultural Experiment Station of the toads released at Belle Glade and Canal Point except that within a year of that event some of the toads were taken 1½ miles from the point of release, and that some in captivity were feeding well but had not bred (Lobdell, 1937). In an article in the "Florida Times-Union" of Jacksonville for 10 March 1944, Josiah Ferris, the person responsible for releasing toads at Clewiston, is quoted as saying the Puerto Rican toads "were unable to withstand the cold." Oliver (1949: 32) regards the Clewiston attempt a failure. The sixth edition of the North American herpetological checklist (Schmidt, 1953) does not mention *Bufo marinus* as an introduced form. This may be merely an inadvertent omission, since at least one nonsurviving introduction is mentioned. In 1955 Oliver (p. 27) still thought the toads were absent in Florida. Announcement of the establishment of the species in Florida is made by Neill (1957: 207), and he personally assures me of its current presence in the Miami area. Duellman and Schwartz (1958) quote Neil Bell as having observed calling males, mated pairs, and tadpoles in or near that city. Dennis R. Paulson is quoted by them as saying that the population at Miami was thriving during the summer of 1957. In spite of this, they indicate only a single specimen extant in collections from south of Fort Lauderdale, Florida, namely University of Michigan Museum of Zoology number 113000. Additional specimens from north of this level are said to be present in the E. R. Allen—W. T. Neill collection.

Bufo arenarum and *Bufo paracnemis*

Following apparent failure of the Clewiston introduction of *Bufo marinus,* the United States Sugar Corporation attempted to import toads which were more cold hardy. A series was procured from the Agricultural Experiment Station of Tucuman, Argentina, and flown to this country as war material. This introduction, never considered in the identification of giant toads from Florida, was reported in several South American newspapers, and on 10 March 1944 in the "Florida Times-Union," on 13 August 1944 in "The American Weekly," and later in Copeia (Myers, 1945).

Coleman J. Goin of the University of Florida, being interested in the outcome of these introductions, wrote to B. A. Bourne, Vice President and Director of Research of the United States Sugar Corporation at Clewiston, Florida, and received this reply dated 25 February 1947:

"On March 8, 1944 we received 16 specimens of *Bufo paracnemis* and 54 specimens of *Bufo arenarum* from Argentina. Up to the fall of 1945 when our Entomologist resigned, he reported that these species had failed to reproduce in the special ponds created for them. However, before leaving us he released the specimens and no proper check has been made to determine whether these species finally reproduced themselves subsequently."

To my knowledge no mention has been made in the herpetological literature of these toads occurring in Florida except the initial announcement by Myers. This omission may be due to the fact that some workers consider these two species to be conspecific with *Bufo marinus.* Although this may be true, examples from the localities from which introduced toads are known to have been derived are, in any case, wholly distinctive.

Bufo terrestris

All of the species mentioned above attain a large size, indeed, the primary reason for importing them was that their large size enables them to consume large insects in large numbers.

Recently a large toad was captured at the Belle Glade Experiment Station which revived interest there in the fate of the *Bufo marinus* released 22 to 23 years earlier. The toad is a *Bufo terrestris* (University of Florida 9077), the common native form, but is of unusual size for this region. It has a snout-vent length of 109½ mm. Duellman and Schwartz (1958) report other large ones of from 104 to 107 mm. from elsewhere in southern Florida. Neill measures one in the Allen—Neill collection, presumably from Florida, as 112 or 113 mm. Comparably large *B. terrestris* are known from elsewhere in the southeastern states. (Though data are lacking, the exotic *Bufo* in Florida probably rarely exceed 150 mm. in length. Neill cites 167 mm. for a *B. marinus* as the maximum measurement known to him.) Whether these large *terrestris* are merely individual growth anomalies or represent populations which attain exceptional size is not definitely established. The size and appearance of the Belle Glade individual has occasioned genuine surprise on the part of several veteran herpetologists long famliar with the Floridian fauna. Logically then it might also be expected to create concern or alarm on the part of laymen, and hence furnish good copy for journalists.

Because any one of four species might be involved, it is important that the guilty party in "toad incidents" be carefully identified, and the accused animal should be saved as a voucher. At this time it is likely that the only exotic *Bufo* surviving now in Florida is *B. marinus,* and probably only in the area of Miami, but the facts are not certainly known. If this is true we may well consider ourselves fortunate, for wherever this animal has been a really successful introduction it has been so at the expense of the native anuran fauna (see for example, Rabor, 1952).

I am indebted to Coleman Goin for providing much of the material on which this report is based and to Wilfred Neill for many helpful criticisms.

LITERATURE CITED

ALLEN, ROSS, and WILFRED T. NEILL
1958. Giant toad from the tropics. Florida Wildlife, vol. 12, no. 4, pp. 30-32, 42, (September).

DUELLMAN, WILLIAM E., and ALBERT SCHWARTZ
1958. Amphibians and Reptiles of southern Florida. Bull. Florida State Mus., vol. 3, no. 5, pp. 181-324.

LOBDELL, R. N.
1936. Field and laboratory studies upon insect pests of south Florida with particular reference to methods of control. Ann. Rept. for 1936, Agr. Exp. Sta., Univ. Florida, pp. 123-124.
1937. Insect pests and their control. Ann. Rept. for 1937, Agr. Exp. Sta., Univ. Florida, pp. 141-142.

MYERS, GEORGE S.
1945. Possible introduction of Argentine toads into Florida. Copeia, 1945, no. 1, p. 44.

NEILL, WILFRED T.
1957. Historical biogeography of present-day Florida. Bull. Florida State Mus., vol. 2, no. 7, pp. 175-220.

OLIVER, JAMES A.
1949. The peripatetic toad. Nat. Hist., vol. 58, no. 1, pp. 29-33.
1955. The natural history of North American amphibians and reptiles. Princeton, New Jersey: D. van Nostrand Company, Inc., xii + 359 pp.

RABOR, DIOSCORO S.
1952. Preliminary notes on the giant toad, *Bufo marinus* (Linn.), in the Philippine Islands. Copeia, 1952, no. 4, pp. 281-282.

SCHMIDT, KARL P.
1953. A check list of North American amphibians and reptiles, sixth edition. American Society of Ichthyologists and Herpetologists, viii + 280 pp.

ANTIBODY RESPONSE TO RAT GASTRIC MUCOSA[1, 2]

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Unlike other rat tissues, the gastric mucosa is resistant to spontaneous and chemical carcinogenesis. The high incidence of gastric carcinoma in man indicates that he does not share this resistance (Berenblum and Haran, 1955; Ray *et al.*, 1953; Sugiura, 1942). Other rat tissues do not have this immunity; consequently, we felt it would be profitable to explore the hypothesis that there is a constituent peculiar to the rat stomach having a protective effect, or which, although providing the locus of primary carcinogenic attack in other organs, is absent from the rat stomach. To investigate this hypothesis we compared the antigenic components of rat stomach with those of other rat tissues. Immunochemical procedures, although far from ideal, provide a means of studying relationships in complex mixtures for which there exist no other available methods. While it is recognized that certain antigen-antibody combinations may not be detected by this test, we have chosen the complement fixation procedure as a means of studying these interrelationships because of its high sensitivity, its applicability to testing of non-soluble antigens, and small amounts of materials required for the test. Preparation of antiserum to gastric mucosa was chosen as the point of attack. Several examples of organ antisera of varying specificity have been reported. Pressman and co-workers succeeded in obtaining antibodies with tissue-localizing properties to such tissues as kidney and lung (Pressman and Sherman, 1951), Wagner osteogenic sarcoma (Wagner and Korngold, 1953), and placenta (1957). As examples of purely glandular tissues, Witebsky (1955, 1956) reported the preparation of antisera to crude thyroid and pancreatic extracts which are organ and species specific. In the stomach he found lipid antigens from a gastric cancer which do not cross-react with similar preparations from normal stomach, although lipid extracts from both normal and malignant stomach tissue reacted with antiserum to kidney

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[3] Our thanks are due to Dr. A. V. Herzberg for helpful suggestions and to Miss Vera C. Glocklin and Mrs. Dolores Gerber for assistance.

lipids. Tokutomi (1953), using saline extracts, presented evidence that ribonucleic acid of hog gastric mucosa is the sole antigen specific to this tissue.

We started with the mixture which is easiest to prepare from gastric mucosa; a simple scraping of glandular gastric mucosa from which blood has been removed by washing with distilled water. This preparation should retain lipid components as well as part of the nucleic acids, proteins, and mucopolysaccharides.

Materials and Methods

A. *Preparatiton of antigen.* Stomachs were removed from rats freshly killed by ether anesthesia. The contents were removed by washing in ice-cold physiological saline containing 1:10,000 merthiolate. The glandular portion was removed by scraping and the pooled mucosas from 5 to 10 rats were kept in an ice-bath. Blood was removed by 2 gentle washings with distilled water, and solids separated by centrifugation at 1800 g for 15 minutes. The second wash showed very little pink color. However, discarded supernatants were translucent, indicating some loss of cellular material. The tissue was then suspended in a minimum amount of distilled water, homogenized, and lyophilized. This antigen was used both for injection into rabbits to produce antisera, and as antigen in all complement fixation tests against gastric mucosa. For preliminary experiments, organs were removed from groups of 5 freshly killed rats, pooled, washed in the homogenizer and lyophilized. It was later found necessary to modify this procedure because in liver and kidney, a considerable amount of tissue material was discarded with the wash water. Accordingly the organs were removed from rats which had been perfused through the abdominal aorta, washed in cold saline containing 1:10,000 merthiolate, pooled and stored in dry ice. They were then homogenized thoroughly with a minimum amount of distilled water and lyophilized. These lyophilized tissues were stored over phosphorus pentoxide in vacuum at 4° C. For use in complement fixation tests weighed amounts of lyophilized tissues were homogenized in veronal buffer until a uniform suspension of material was obtained.

B. *Complement fixation procedure.* During early experiments, the procedure was that of Zinsser (Smith, *et al.*, 1948), later modified to include the recommendations of Plescia (1956). The 50%

hemolytic unit of complement was determined daily using freshly reconstituted complement. The 50% hemolytic unit of hemolysin was determined at intervals of 2 to 3 weeks whenever fresh 1:2000 dilutions were prepared. Complement was fixed by overnight incubation at 4° C. Hemolysis was carried out for 60 minutes at 37° C., shaking every 15 minutes. The reaction was terminated by adding a constant volume of ice cold saline. After centrifuging out unhemolyzed cells, optical density was read in a Coleman Junior Spectrophotometer, model 6A, at 576 mμ. Endpoints of 50% hemolysis were estimated graphically and are reported as the reciprocal of the number of ml of serum required for 50% hemolysis in presence of constant quantity of antigen. Veronal buffer at pH 7.3-7.4 containing calcium and magnesium ions and 1:10,000 merthiolate was used for all dilutions.

C. *Preparation of antisera.* Most of the sera were produced by intramuscular injection of antigen in combination with Freund's adjuvant. Primary immunization was always carried out with a series of 3 injections. Serum complement was inactivated by heating at 56° C. for 30 minutes and the serum stored in sterile serum bottles at 4° C. after addition of 1:10,000 merthiolate.

D. *Absorption procedure.* Absorptions were carried out by maintaining the serum diluted 1:8 in contact with lyophilized tissues from perfused animals for at least 24 hours at 4° C. Serum was separated from tissue by centrifugation at 1800g and tested for completeness of absorption by titrating against absorbing tissue. Adult rabbits were obtained locally or from Rockland Farms, N. Y. Rats were male Sprague-Dawley albinos, obtained from Holtzman Rat Co. Complement and sheep's red blood cells were obtained from Markham Laboratories, Chicago. Hemolysin and Freund's adjuvant (complete Bacto-adjuvant) supplies were obtained from Difco Laboratories.

RESULTS

A. *Complement fixation.* Increasing reaction times for fixation and hemolysis from 30 to 60 minutes resulted in titers only a little higher than those obtained by clinical procedure. When, however, time of fixation was overnight at 4° C., a much higher titer was obtained. Although the titer of immune sera was increased more than 3-fold by overnight fixation, that on non-immune serum was not appreciably affected, indicating that greater fixation of complement during longer reaction time was indeed a requirement for formation of antigen-antibody complexes, rather than a non-specific fixation.

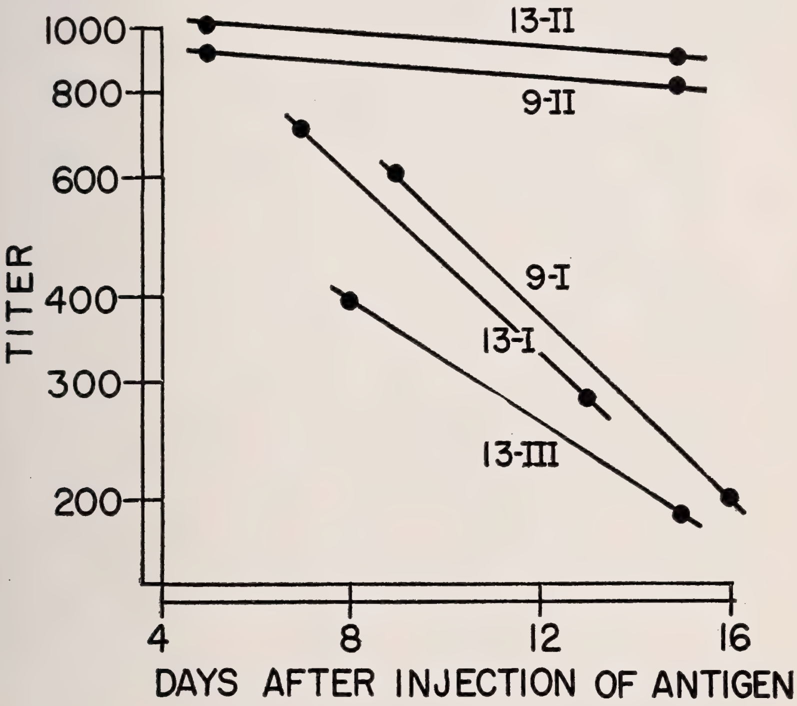

Figure 1. Persistence of rat gastric antibody *in vivo.* Effect of time interval between immunizations.

Curve 9-I. Primary type of response from animal No. 9.

Curve 9-II. Secondary response in the same animal 3 weeks after administration of previous injection.

Curve 13-I. Primary type response in animal No. 13.

Curve 13-II. Secondary response in the same animal 3 weeks after administration of previous injection.

Curve 13-III. Third injection 7 weeks after the second injection in the same animal, typical of a primary response.

B. *Preparation of high titer sera.* Various methods of administering antigen, including intraperitoneal, subcutaneous, and intravenous, were tried on separate rabbits, but did not yield sera of higher titer than that obtained by intramuscular plus adjuvant.

For primary immunization small quantities of antigen at frequent intervals appear to be more effective than larger amounts given over longer intervals. Fig. 1 shows that when an injection series followed the previous one by 3 weeks (9II, 13II) a typical secondary response with slow decrease in titer occurred. When, however, the second series followed the first by 7 weeks or more, the response reverted to that of a primary type (9I, 13I, 13III) (Boyd, 1956). The antigenic mixture from rat gastric mucosa apparently elicits a response similar to the homologous lens antigen of Halbert, *et al.* (1957), in that a rapidly attained peak was followed by a rapid decrease. This type of response is unusual when Freund's adjuvant is employed.

C. *Stability of antisera in vitro.* A serious complicating factor has been the decrease of titer of some sera on storage at 4° C. with 1:10,000 merthiolate as a preservative. Our results indicate that antibodies in blood withdrawn 15 days after injection may have greater *in vitro* stability than those in blood taken earlier.

D. *Reaction of anti-rat gastric mucosa antiserum with tissues other than rat stomach.* In any experiment in which an organ is used as antigen it is important to determine the degree of specificity of the serum. Antisera from neither of the 2 rabbits studied in detail reacted appreciably with rat serum diluted 1:10; also the titer of antiserum from rabbit 9 was not decreased by absorption with rat red blood cells (Table II). This established the absence of species-specific antibodies in antisera, and also eliminated the possibility that any cross-reactions observed with various organs might be due to blood retained in them.

The decrease in titer with time, observed when antiserum was titrated against stomach, was noted also when antiserum was titrated periodically against kidney, but was not seen when lung was used as antigen in the complement fixation test (Fig. 3). When the bulk of antibodies reacting with lung had been removed by absorption, however, the residual titer against this tissue also decreased with time, as shown by the constant ratio of titers against stomach and lung in Table I, indicating that the more stable antibodies had been absorbed.

Of the organs tested, lung, kidney, and intestinal mucosa reacted with antiserum to nearly the same extent as gastric mucosa. Esophagus, liver, heart, pancreas and abdominal muscle reacted

TABLE 1. ABSORPTION OF GASTRIC ANTI-RAT SERA WITH RAT LUNG AND KIDNEY.

				Antigen Used in Complement Fixation					
							Kidney Titers		
Serum No.	Antigen used for absorption	Blank titer (no antigen)	Ratio blank titer/ stomach titer	Stomach titer .05%	Lung titer .1%	Ratio lung titer/ stomach titer	.05%	.1%	Ratio kidney titer/ stomach titer
9A	Lung	45	.4	120	55	.5			
	None			210	160	.8			
9C	Lung	105	.4	265	130	.5	180		.7
	None			500	290[*]	.6	310[*]		.6
"	Lung	150	.4	410	190	.5	280		.7
	None			570	290[*]	.5	340		.6
"	Lung	30	.4	85	45	.5	50		.6
	None			245	290	1.2	75		.3
"	Lung + Kid.	60	.4	140				70	.5
"	"	145	.4	330	280	.9		330	1.0
"	"	110	.4	280	230	.8		330	1.2

[*] Where comparable figures are not available for titrations on unabsorbed serum at the time corresponding to titration for the absorbed, titers are estimated from Figures.

to a lesser extent. Fig. 2 shows type of data obtained in our early experiments when varying concentrations of these tissues were tested against serially diluted antiserum. In the later experiments the antigen was more finely dispersed; the more sensitive complement fixation procedure was used; and the soluble fraction was not removed. However, Fig. 4, 5 and 6 show that, generally, increasing antigen concentration requires a higher dilution of antiserum to reach the 50% hemolytic endpoint, and that a maximum dilution is reached beyond which the serum does not react with antigen at any concentration. Tissue concentration and serum dilution at which this maximum is reached vary from tissue to tissue, indicating a variation in concentration of cross-reacting antigenic substances in the different tissues as well as varying concentrations of antibodies in the heterogeneous antiserum.

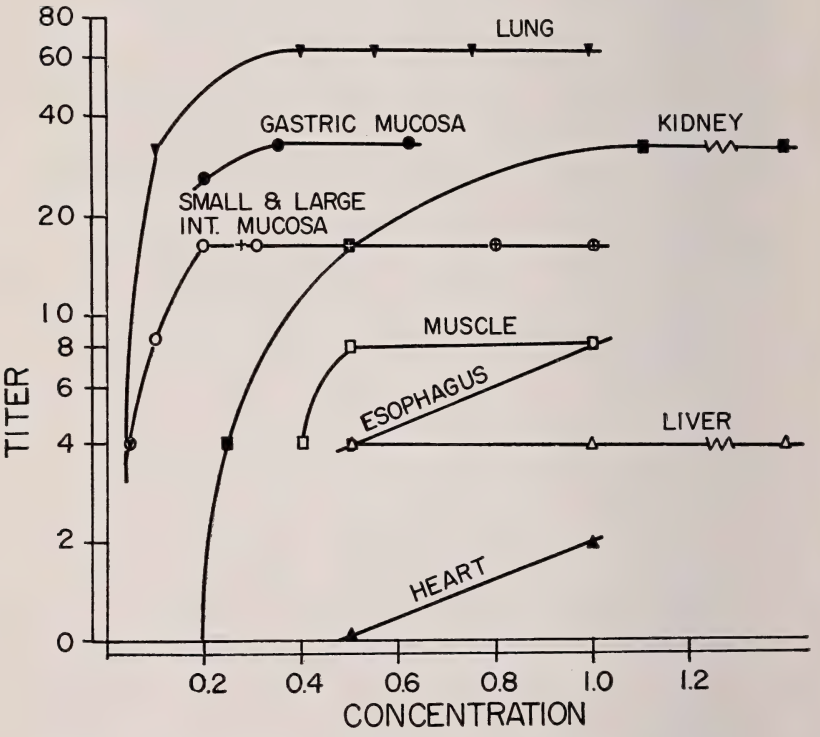

Figure 2. Cross reaction of various rat tissues with anti-stomach sera. Concentrations expressed in per cent tissue.

It is seen that in lung (Fig. 2 and 6), and pancreas (Fig. 4), maximum titer is reached at fairly low tissue concentrations, while a much higher concentration is necessary in kidney (Fig. 2). In fact, with finely dispersed preparations of whole perfused kidney and serum 9C (Fig. 5) no maximum endpoint could be detected to the point where the tissue itself became anticomplementary. A

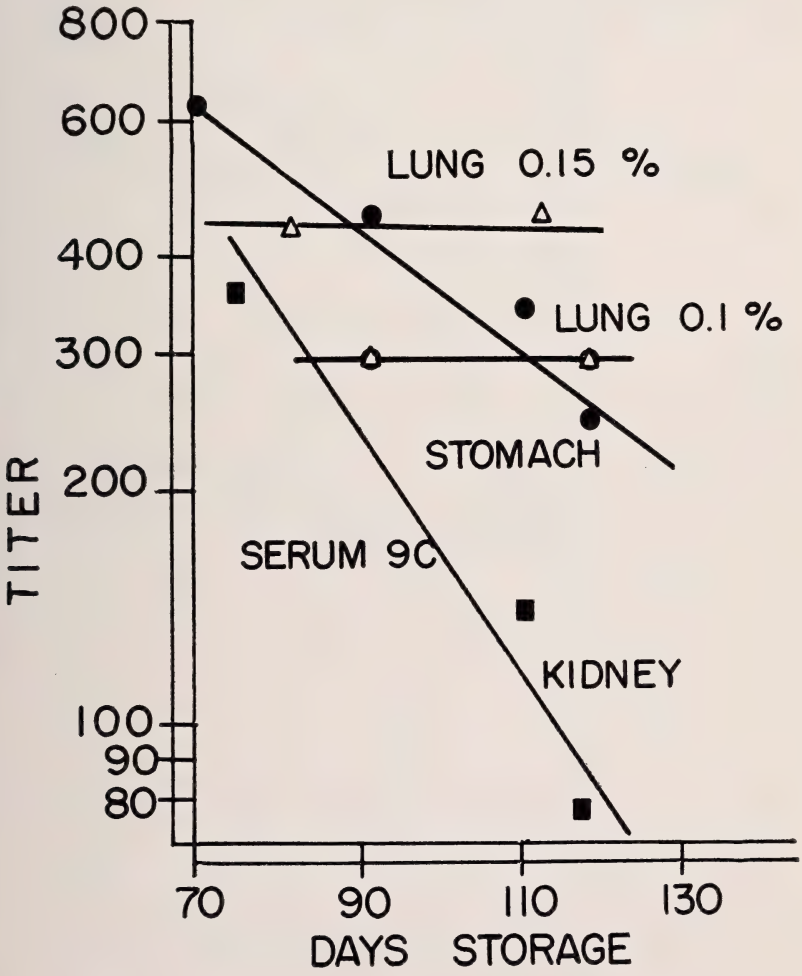

Figure 3. Decrease in titer of gastric anti-rat sera on storage at 4° C. Difference in stability between lung response, and stomach and kidney is noteworthy.

trend toward a maximum appeared with the perfused preparation of intestinal mucosa (Fig. 4) but the supply of serum was exhausted before it was possible to extend the titrations beyond 0.3%, which was definitely a saturating concentration in the case of washed homogenates, and a higher concentration of tissue than

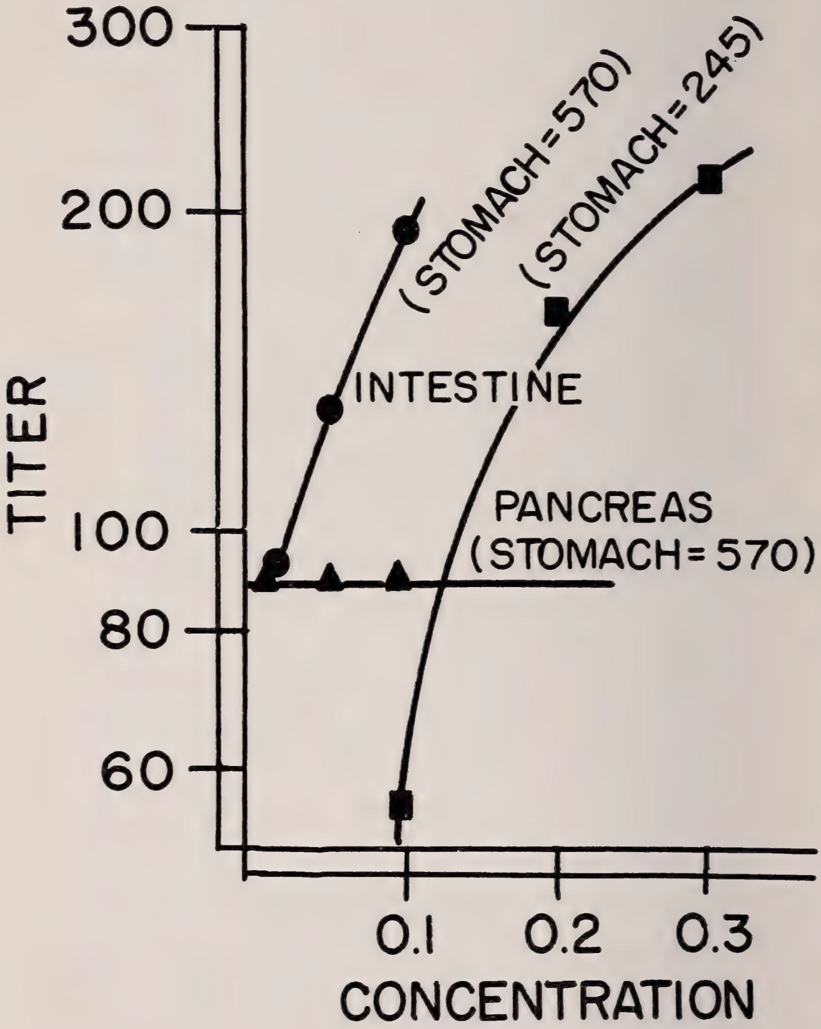

Figure 4. Relation between titer and antigen concentration of gastric anti-rat sera using intestine and pancreas as antigen. Serum 9C. Concentration in per cent tissue. Titers of each serum with stomach given in parenthesis.

required for a similar titer using gastric mucosa (Fig. 2). It appears that some of the cross-reacting antigenic substances are present in lower concentration in intestinal mucosa than in gastric mucosa.

E. *Absorption of anti-stomach antiserum with other tissues.* Since qualitative tests showed that a good share of the complement fixing activity of the stomach, lung, and kidney antigens resided in the saline-insoluble portions, it seemed that it might be possible to clarify some of the antigenic interrelationships of the organs by absorption procedures. This has proved possible with lung and

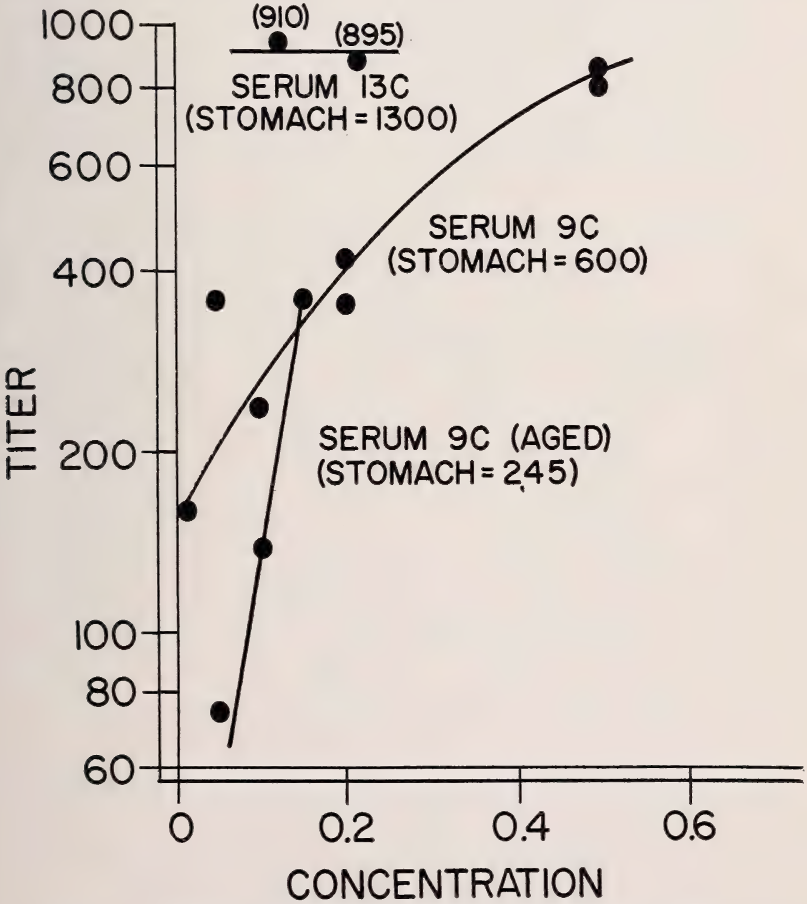

Figure 5. Relation between titer and antigen concentration using kidney as antigen. Gastric anti-rat sera as marked. Concentration in per cent tissue.

pancreas, which show a pattern of depletion of the antiserum as tissue concentration is increased.

The pancreas, according to Witebsky (1956), exhibits a high order of organ and species specificity. The present experiments confirm this concept both from the point of view of the low maximum titer obtained using this organ as antigen, and from the fact few, if any, antibodies reacting with stomach, lung or kidney were removed when antiserum from Rabbit 9 was reacted with it as shown in Table II.

It has been possible to react antiserum from Rabbit 9 with lung tissue, so that very little residual reactivity with lung is demonstrated, but the serum retains some capacity to react with stomach and kidney, indicating there are antigens in kidney and in stomach which have no counterpart in lung. The data are given in Table I, in which the figures have been converted to ratios to correct for the

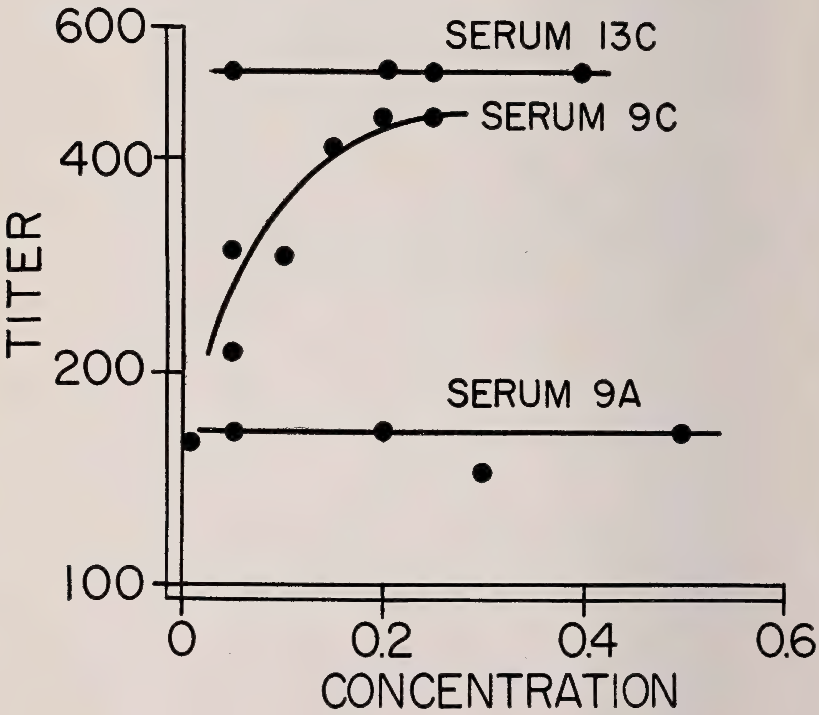

Figure 6. Relation between titer and antigen concentration using lung as antigen. Gastric anti-rat sera as marked. Concentration in per cent tissue.

TABLE II. EFFECT OF ABSORPTION WITH RAT PANCREAS AND RED BLOOD CELLS ON GASTRIC ANTI-RAT SERUM FROM RABBIT No. 9.

	Antigen Used in Complement Fixation							
Antiserum 9	Stomach titer	Pancreas titer	Ratio pancreas titer/ stomach titer	Lung titer	Ratio lung titer/ stomach titer	Kidney titer	Ratio kidney titer/ stomach titer	Blank titer (no antigen)
Before absorption with pancreas	245	70	.3	290	1.2	140	.6	
After absorption with pancreas	260	60	.2	210	.8	155	.6	70
Before absorption with red cells	570							
After absorption with red cells	650							

instability of the antiserum, although actual titers are also indicated in the table. For absorbed serum, a titer was obtained in the absence of added antigen, as indicated in the column labeled "Blank Titer." This is believed to be due to the presence of soluble antigen-antibody complexes which fix complement, and which are not thrown down by the centrifugation procedure.

It is seen that although the titers against lung and stomach are reduced in varying degrees by absorption, the ratio of lung to stomach is constant after absorption and is very close to that obtained with no antigen. Absorption with lung had apparently removed the more stable antibody. Line 1, Table I, represents serum taken earlier. Line 2 represents a separate absorption experiment on serum collected at the same time as that used for the data in lines 3 and 4. In all cases it can be seen that a single treatment with lung lowers the titer against this tissue to a level which approximated that for no antigen, while the titer against stomach is double that of the lung. Lines 3 and 4 of Table I represent titrations at an interval of 12 days, and show that although the titer of the unabsorbed serum against lung was constant during this period, that of the absorbed serum decreased.

TABLE III. TITERS OF GASTRIC ANTI-RAT SERA WITH RAT LUNG AND KIDNEY.

	Antigen Used for Complement Fixation		
Serum	Lung, .2%	Kidney, .05%	Lung, .2% + Kidney, .05%
9C	450	140	750
13C	520	550	750
Non-immune	15	50	45

Cross reaction of organ antisera with lung, liver and kidney seems to be fairly generalized (Goodman, 1955; Maculla, 1947-48; Pressman, 1951). Evidence that the cross reacting antigens of the lung and kidney are not in all respects identical is given by the experiment illustrated in Table III (for which the data were obtained at about the same time as line 6 of Table I. Here it is seen that when the complement fixation titration is run in the presence of an amount of lung tissue sufficient for maximum absorption, further reaction is demonstrable when kidney tissue is present at the same time, and the combined titer is higher than with either lung or kidney alone.

SUMMARY

The water-insoluble portion of rat gastric mucosa has been shown to be antigenic to rabbits. A serum with high complement-fixation titer can be obtained by use of Freund's adjuvant and frequent reimmunization to take advantage of the anamnestic response. The antiserum from at least one rabbit appeared to have antibodies for the rat gastric mucosa.

LITERATURE CITED

BERENBLUM, I., and N. HARAN

1955. The Influence of Dose of Carcinogen, Emptiness of Stomach, and Other Factors on Tumor Induction in the Forestomach of the Mouse. Cancer Research, 15: 504-508.

BOYD, W. C.

1956. Fundamentals of Immunology, 3d ed. New York: Interscience Publisher, Inc.

GOODMAN, M.; S. A. GREENSPON, and C. A. KRAKOWER

1955. The Antigenic Composition of the Various Anatomic Structures of the Canine Kidney. J. Immunol., 75: 96-104.

HALBERT, S. P.; D. LOCATCHER-KHORAZO; L. SWICK; R. WITMER; B. SEEGAL, and P. FITZGERALD

1957. Homologuous Immunological Studies of Ocular Lens. I. In Vitro Observations. J. Exper. Med., 105: 439-453.

MACULLA, E. S.

1947. The Immunochemistry of Mouse Tissue Components: I. Comparative Antigenic Composition of Normal Mouse Tissue. Yale J. Biol. and Med., 20: 299-314.

PLESCIA, O. J.

1956. Immunochemistry in Cancer Research. Cancer Research, 16:743-752.

PRESSMAN, D., and L. KORNGOLD

1953. The *In Vivo* Localization of Anti-Wagner-Osteogenic-Sarcoma Antibodies. Cancer, 6: 619-623.

1957. Localizing Properties of Anti-Placenta Serum. J. Immunol., 78: 75-78.

PRESSMAN, D., and B. SHERMAN

1951. The Zone of Localization of Antibodies. XII. Immunological Specificities and Cross Reactions in the Vascular Beds of Liver, Kidney and Lung. J. Immunol., 67: 21-23.

RAY, F. E.; P. CAMBEL; M. L. JUNG; J. H. PETERS; and S. A. WOISLAWSKI

1953. New Attack on the Problem of Experimental Gastric Cancer. J. Nat. Cancer Inst., 13: 955-962.

SMITH, D. T.; D. S. MARTIN; *et al.*

1948. Zinsser's Textbook of Bacteriology. 10th ed. New York: Appleton-Century-Crofts, Inc.

SUGIURA, K.

1942. The Relation of Diet to the Development of Gastric Lesions in the Rat. Cancer Research, 2: 770-775.

TOKUTOMI, K.

1953. Fractionation of Pig Gastric Mucosa and the Properties, Particularly Antigenicity, of the High-molecular Components Separated. II. Tohohu J. Exper. Med., 59: 177-192.

WITEBSKY, E.; N. R. ROSE; and S. SHULMAN

1955. Studies on Organ Specificity. I. The Serological Specificity of Thyroid Extracts. J. Immunol., 75: 269-281.

1956. Studies of Normal and Malignant Tissue Antigens. Cancer Research, 16: 831-841.

LUIGI FERDINANDO MARSIGLI, THE LOST FATHER OF OCEANOGRAPHY

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It is now generally admitted that Matthew Fontaine Maury was the first person to establish the science of oceanography. In addition to his Pilot Charts of the Oceans, this recognition is due in large part to the publication of his "Physical Geography of the Sea" in which he attempted to treat the oceans as a whole and as a legitimate object of scientific study. There seems little doubt that Maury deserves his reputation, for he did have great influence on the development of oceanography. In this paper, we wish to call attention to an extraordinary person, antedating Maury by about 150 years, who but for some quirks of fate, should have been regarded as the Father of Oceanography. Count Luigi Marsigli[2], by his publications and letters to various people, clearly demonstrated that he, by his experiments, keen observations and measurements, and by his lucid descriptions of the physical factors responsible for the effects he noted, had a true appreciation of the place of oceanography among the sciences. Although he wrote a text entitled "Histoire Physique de la mer", published in 1725, as well as many other works, his name is now little more than a curiosity. It is this fact that led us into an enquiry into his life and works to try to determine why it is that his efforts were ignored and why the development of oceanography suffered not a "lost week-end" but a "lost century".

Marsigli's life was not an idle one. He was born of noble birth to the Count and Countess Marsigli on July 20, 1658, in Bologna. Little is known of his childhood. In Marsigli's autobiography, his first reference to his early life is that at the age of 18 he lost his beloved mother. It is known, however, that during these early years Marsigli made extensive but irregular studies in all phases of science as it was known then. At Bologna he studied under Malpighi, the botanist Triofetti and the mathematician Montanari. In 1674 he resumed his travels and went to Padova and Venice, where he continued his studies. Two years later he was in Rome and the next year in Naples, Pozzuoli and Vesuvio. In 1679 he accompanied Bailiff Pietro Civrano to Constantinople and in the next eleven months touched at Adrianople, Sofia, Belgrade and Bosnia. During all his travels, Marsigli found time to continue his scientific observations. He was greatly inspired by the experimental method of Galileo and applied this method wherever possible to his observations of the sea. In his travels he noted the unity and design of nature, that physical and chemical researches are associated with the biology of the sea and that ocean basins are related structurally to the mountains and are a continuation of the same. Marsigli, with his acute powers of observation, was well ahead of his time not only in scientific research, but in attitude as well. In all his writings, he consistently avoided unfounded speculation and the repeating of statements made by others unless he had made direct observations to support these statements. In a certain sense, his scientific attitude closely paralleled that of our modern operationalists.

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[1] U. S. Navy Mine Defense Laboratory.

[2] Spelled also Marsili, Marsilli, Marsillij.

In 1681, Marsigli returned to Rome where he was received by that most anomalous and excentric among history's rulers, Queen Christina of Sweden. To her, he dedicated his first work, "Osservazioni intorno al Bosforo Tracio o vero Canale di Costantinopoli". In this remarkable work he describes the currents in the Bosporus and shows that the surface current flows from the Black Sea to the Mediterranean and below this is a countercurrent flowing in the opposite direction. It was not enough for Marsigli to take the word of local fishermen. Instead, he devised a propeller type of current meter and made actual measurements. He then made the hypothesis that the currents were due to density differences and that the surface current was the result of the excess of evaporation over precipitation in the Mediterranean, causing the lighter water from the Black Sea to flow through the Bosporus into the Mediterranean and this water had to be replaced by denser water from the Mediterranean. This hypothesis was verified by taking water samples at various depths and determining the salinity by evaporation, weighing the residue. But even this was not enough for Marsigli. He made a model of the system by putting a partition in a large tank. The partition had a valve at the top and one at the bottom. On filling one side with light water, the other with dense water and on opening both valves simultaneously, he observed the same type of current pattern. Certainly, even today, no one could criticize his scientific attitude or technic. This discovery and explanation of density currents is evidence of Marsigli's scientific abilities and in itself should be sufficient to establish him as one of the founders of oceanography.

In 1682, Marsigli's life took another turn. He was called to enter the services of Emperor Leopold I of Austria to help in the fight against the Turks. The following year he was placed in command of a company of infantry and during a battle, was taken prisoner. The Turks took him to Budapest where he was sold to two brothers from Bosnia. Fortunately, he was soon ransomed and returned to Italy in March of 1684. After a brief rest, he returned to battle and participated in the siege of Neuhäusel (Ersekujvar). In 1686 he took part in the siege and capture of Buda. In this battle a gunshot wound broke his arm, and he was retired from battle to the Hungarian capital. Seeming misfortune proved to be a stroke of luck. In the Hungarian capital he was able to acquire many valuable books about the city, draw plans of the city, measure monuments and compile a mass of material for the study of Buda in those times. As a result, he was invited to Rome to tell of his work. Turning again to arms, he was destined to stabilize lines of defense, fortify cities and give suggestions for sieges. A short time later he was present at the occupation of Semendria, near Belgrade and at the battle of Vidin. In 1691 he journeyed to Adrianople and Constantinople where he was active in negotiating with the Turks, for which he was made a colonel. In 1693 he was wounded in the siege of Belgrade. Following this, Marsigli's activities were varied; brief rests, army maneuvers, building bridges and roads and various other activities until the year 1699. Since he had no official title, he was able to participate in the peace negotiations with the Turks at Carlowitz and to set up the boundaries of the two empires, Turkey and Hungary.

Even during periods of intense military activity, Marsigli continued his studies of the dynamics and biology of water. His monumental work "Danubius Pannonico-Mysicus" was done at this time, along with other researches on geography, astronomy, ethnography and a development of the study of hydrography.

With the onset of the War of the Spanish Succession, Marsigli again entered military service. He was appointed second in command under Count Arco in the defense of Alt-Breisach. Although the fortress was surrendered by Count Arco to the Duke of Burgundy, both Arco and Marsigli were court-martialled. Count Arco was condemned to death and Marsigli was cashiered and publicly disgraced. Although he was acquitted of blame by public opinion, Marsigli's honor had been tainted and he deeply resented his sentence. Soon afterwards he went to Switzerland, where he wrote a strong protest against his sentence. His autobiography (which was not published until 1930) apparently was written in an effort to defend his military honor. There is disappointingly little in it regarding his scientific work. For example, he dismisses his work on the Bosporus with one short paragraph. Despite Marsigli's protests, he was never fully reinstated in the military service.

Marsigli's period of greatest activity in oceanography corresponds to his stay at Cassis, a French fishing village about 25 miles southeast of Marseilles from 1705 to 1706. In a letter to one of his friends, a M. Bignon, he wrote: "I have begun research on the history of the sea, where I hope to treat the nature of the water of the sea and its diverse movements; of the differences of the bottoms of the sea, which seem to me to be related to the structure of the mountains, of the effect of winds on this water, of the nature of fish developed by means of analysis of the vegetation growing on the bottome of the sea." The results of his two years work at Cassis was his monumental work "Histoire physique de la mer," which, however, was not published until 1725. This productive period, lasting hardly two years was interrupted by his again being called to military service, this time by Pope Clement XI. Again in 1715 he was asked to serve the Pope. This was his last time. When the threat of war ended, he retired from military service and devoted the rest of his life to his studies. His vast collection of scientific material was presented to his native city of Bologna in the founding of the Bologna Institute of Science and Art the 13th of March, 1714. He soon afterward travelled to England where he became friends with Newton and Halley and in 1722 he was made a Fellow of the Royal Society. He was elected to the Paris Academy of Science in 1715. After two trips to Holland, Marsigli returned to Maderno sul Garda in 1725. In this period he wrote the monograph "Osservazioni fisiche intorno al lago di Garda detto anticamente Benaco." This was published posthumously in Bologna in 1930.

Count Luigi Ferdinando Marsigli died in Bologna on November 1, 1730, at the age of 72. As far as is known, he never married. In his autobiography, he does mention that in his youth he met a beautiful Eleanora and saw his family to make arrangements for marriage only to find that when he returned to her home, the beautiful Eleanora had just married one of his friends.

His "Histoire Physique de la Mer" is a remarkable book in many ways. The eleven page preface by Herman Boerhaave in Latin and French is well worth reading. He says among other things that Marsigli was reared in the "Ecole de Mars," but in spite of campaigns, horrors of war, the drinking and whoring of soldiers, Marsigli found time to study nature, wrest her secrets and to live the good life. In the book itself, Marsigli tells of his disappointment in finding no accurate charts of the shorelines around Cassis. He found it necessary to survey several hundred miles of shore line. Comparing his maps with present day charts, it is obvious that he did a good job of surveying almost singlehanded. He also realized the necessity for bottom soundings and made about 15 transects, noting depths, bottom sediments and type of vegetation. The difficulties which early workers faced is brought sharply to our attention in his description of his efforts to get a yearly set of temperature measurements. He had *one* thermometer and this he valued highly. After making systematic temperature measurements for eight months, he was surprised by pirates and in the struggle to escape, the thermometer was broken and his temperature measuring had to be discontinued. Marsigli was keenly aware of the relation between biology and physics. In his biological studies, he made a statement which to us may seem odd or naive, yet, considering the times, it shows him to be a true scientist. He said that the life of the sea may be divided into two parts: those things which may be eaten and those which cannot be eaten. Since much was known of the things which could be eaten (fish, shellfish) he was going to devote his efforts to studying the things which could not be eaten.

Some of his efforts will now be regarded as pathetic. For example, he seemed to realize that to understand the nature of marine organisms, one must know something of the chemistry of the organism. He made hundreds of chemical "analyses" in which he would weigh carefully certain parts of the organism, treat it with various of the then known chemicals and then weigh the residue. Much of his book is devoted to a laborious listing of his results. Yet, with the poor state of chemistry at that time, the significance of his work is obviously impossible to understand. In spite of this, one gets the feeling that Marsigli was on the right track but 150 years too soon.

It is ironic that today Marsigli is better known for one mistake than for many of his valid contributions. In the Mediterranean, Red Coral is valuable for jewelry and Marsigli was interested in knowing something of the nature of coral. He was certainly one of the first to make systematic observations of coral polyps but when he saw through his "good microscope," coral "all covered with white flowers, each with eight equally spaced rays" and having noted the resemblance between corals and coraline algae, one can hardly blame him for concluding that they were plants. Peysonnel, a physician from Marseilles opposed Marsigli's conclusion and thus arose what is now known as the Peysonnel-Marsigli controversy.

We may now ask why it is that a man of such talents and such accomplishments failed utterly to gain the recognition he properly deserved and why did the world of science ignore him? Obviously, little will be gained by stating that all pioneers are ahead of their time. Perhaps some insight may be shed by the poet who wrote "Full many a gem of purest ray serene/ the dark unfathomed caves of ocean bear/ full many a flower was born to blush unseen/ and waste its sweetness on the desert air." To be recognized, one must be known. Marsigli was well known during his lifetime, but by military men and diplomats. His name was not kept before the scientists of his day. No doubt Marsigli felt greatly honored that Queen Christina would seek him for enlightenment but it would have been far better if scientists had sought him. As far as is known, Marsigli had no students. Galileo had a Toricelli to spread his fame but Marsigli had no such help.

A recent book by John Baker on the life of Abraham Trembly, the founder of experimental zoology, seems to provide exactly the answer we seek. Baker shows the influence of Reaumur, a long-time friend of Trembly, in bringing Trembly's ideas before the scientific world. It was Reaumur who provided encouragement, friendly criticism and an outlet for Trembly's writings. Marsigli had no such advantage. Baker states: "Had he (Trembly) lived a century sooner, his talents as an investigator would probably have found no outlet. The development of a scientific atmosphere, in which a Trembly could flourish, required the active participation of men endowed with very original minds and forceful personalities. Reaumur was one of these." Marsigli did not live in a scientific atmosphere and the world was much the loser.

REFERENCES

The source material for this paper was taken from widely scattered references, much of it rare and difficult to obtain. The following notes will enable the reader to make a reasonably good choice in selecting material that has further references.

BIBLIOGRAPHY—ANNOTATED

1. The New International Encyclopedia, 2nd edition, Vol. 15, 1917. A very short synopsis of Marsigli's life with a list of his important works.
2. Encyclopedia Britannica, Vol. 14. Contains a short synopsis of Marsigli's life with a good list of his works, plus further references to Marsigli.
3. A Dictionary of Universal Biography, 2nd edition, 1951. Albert M. Hyamson. This gives references to where complete biographies on Marsigli can be found.
4. Dizionario Bio-Bibliografico dei Bibliotecari E Bibliofili Italiani - - Dai. Sec. XIV ai XIX - Carlo Frati, 1933. A few short sentences on Marsigli plus a list of men who have written about Marsigli (this includes about 40 persons) and where these works can be obtained.
5. Universal Pronouncing Dictionary of Biography and Mythology, 4th edition, 1915, Joseph Thomas. A Short and fairly detailed account of Marsigli's life.
6. Library of Congress Catalog of Printed Cards, Vol. 95, 1944. A list of some of Marsigli's works with data on where they can be obtained. We found this to be a valuable reference.
7. Enciclopedia Italiana, XXII, p. 424. Contains the most detailed account of Marsigli's life. Much of the material for this paper was obtained from this source.
8. Encyclopaedia Britannica, 11th edition, Vol. XVII. A fairly good synopsis of Marsigli's life plus a fair list of his works and where they can be obtained.

9. Catalogo Generale della Libreria Italiana, 1921-1930, p. 122, Pagliaini. This book contains 5 interesting references to papers written about or by Marsigli. All of these can be found in the library of the University of Bologna, Bologna, Italy.
10. The Catholic Encyclopedia, Vol. 9, p. 719, 1913. Since Marsigli was a devout Catholic this book contains a sympathetic if somewhat short, account of Marsigli's life. It is particularly interesting in that it dates some of his works according to Catholic holy days or Saint days.
11. Tresor de Livres Rares et Precieux. Vol. 4, pp. 417-418: 1950, Jean George Thedore Graessi. This reference contains a fair list of Marsigli's works and where they can be obtained.
12. John R. Baker, "Abraham Trembly of Geneva," Edward Arnold and Co., London, 259 pp. 1952.
13. Autobiografia di Luigi Ferd. Marsigli, Messa in luce nel 2° centenario dalla morte a cura di Em. Lovarni. In Yale University Library.
14. Osservazioni intorno al Borsforo Tracio o vero Canale di Costantinopoli rappresentate in lettera alla Sacra Real Maesta di Cristina Regina di Svezia da Luigi Ferdinando Marsili. Reprinted in Bollettino di pesca, di piscicoltura e di idrobiologia. Anno XI, Fasc. 5, Settembre-Ottobre 1935, pp. 734-758.
15. Histoire physique de la mer. Ouvrage enrichi de figures dessinees d'apres le Naturel. Par Louis Ferdinand Comte de Marsilli, Membre de l'Academie Royal des Sciences de Paris. A Amsterdam Aux De'Pens de la Compagnie, M DCC. XXV.
16. Memorie della vita del generale Co: Luigi Ferdinando Marsigli dedicate all ' E'mo e Rev'mo Sig. Cardinale Lazzaro Opizio Pollavicini Segretario di Stato di N. S. In Bologna M. DCC. LXX. Per Lelio dalla Volpe Impress. dell ' Istituto delle Science con licenza de'superiori (by Giovanni Fantuzzi). In Harvard College Library. Contains little of scientific interest.

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LEPTOCEPHALUS OF THE ATLANTIC TARPON, *MEGALOPS ATLANTICUS* VALENCIENNES, FROM OFFSHORE WATERS

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Plankton samples were collected as part of the routine biological observations made during cruises of the M/V *Theodore N. Gill* off the south Atlantic coast of the United States during the years 1953 and 1954. The cruises constituted the initial or collecting phase of the U. S. Fish and Wildlife Service's biological, chemical, and oceanographic inventory of the waters from Cape Hatteras, North Carolina to the Straits of Florida from the coast out to beyond the approximate axis of the Gulf Stream. During the examination of fish larvae taken in the plankton tows, in particular the search for leptocephalid larvae of the ten-pounder, *Elops saurus* Linnaeus, one leptocephalid form was found that resembled the ten-pounder larvae in general form (ribbonlike with flattened, triangular head and forked caudal fin), but differed in numbers of dorsal and anal rays (ray bases), and body myomeres. This leptocephalus, 18.0 mm. in standard length, was taken in an oblique tow (65 meters to surface) with a half-meter plankton net at 1225-1249 hours on August 5, 1953, at Regular Station 40 of *T. N. Gill* cruise 3, 31°30′ N. lat., 78°42′ W. long., about 150 miles east and slightly north of Brunswick, Georgia, and well out in the Gulf Stream.

The unusual larval development of the tarpon, the ten-pounder, and the bonefish *Albula vulpes* (Linnaeus), requires special terminology to distinguish the developmental stages since there are two periods of length increase separated by a period of length decrease (the beginning of metamorphosis). I have restricted the term *leptocephalus* to a larva in its initial stage of length increase, up to the size at which shrinking begins; while the term *metamorphic larva* is suggested for a larva undergoing shrinking, during metamorphosis, and subsequent length increase to the juvenile stage (Gehringer, *in press*).

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Whereas the leptocephalus of the ten-pounder has (at the apparent stage of development of the larva in question) 14 to 16 dorsal ray bases and 6 to 8 anal ray bases (Gehringer, *in press*), this leptocephalus has 12 dorsal ray bases and 21 anal ray bases. There are 55-57 myomeres (last 2 or 3 indistinct), whereas the ten-pounder generally has in excess of 75 myomeres. During metamorphosis the ten-pounder develops 21 to 26 dorsal rays (adult complement, 25 to 29) and 12 to 18 anal rays (adult complement, 16 to 19). While it is possible that the number of dorsal ray bases might have increased on the leptocephalus in question during and following metamorphosis, it is not possible for the number of anal rays to decrease, nor for the number of body myomeres to increase to the range for the ten-pounder. The number of anal rays for the bonefish, *A. vulpes,* is 8 or 9 (Hildebrand, 1943), eliminating this species from consideration.

Hildebrand (1934) described a specimen "in transition from the leptocephalid to the adult form" of the Atlantic tarpon, *Megalops atlanticus* Valenciennes,[2] taken in the mouth of Core Creek, Beaufort, North Carolina, August 21, 1929, 20 mm. in total length, with 52 body myomeres, 12 dorsal rays, and 20 anal rays, all distinct. The specimen unfortunately was inadvertently destroyed. Harrington (1958) described a collection of 259 "young" Atlantic tarpon from 16.0 mm. in standard length (18.8 mm. total length) to about 54 mm. in standard length (69.0 mm. total length), bridging the gap between the smallest previously described "post-larval" sizes of Hildebrand's 20-mm. transitional larva and a "post larva" of 42 mm. in standard length described by Breder (1944). Hildebrand's 20-mm. specimen, and Harrington's 18.8-mm. "young" were in a much more advanced stage than my specimen; that is, well-developed dorsal and anal rays were present and pelvic fins were present in their specimens, and Harrington describes the air bladder of his 18.8-mm. larva as of "considerable" size, indicating they had undergone the initial growth of the leptocephalus and shrunk to the size at which subsequent growth begins. The ray and myomere counts leave little doubt that my larva is a tarpon, disregarding the ever-present possibility that some other fish has an undescribed developmental history which could be confused with that of the tarpon.

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[2] Following Bailey's review (1951) of the authorship of names proposed in Cuvier and Valenciennes' Histoire Naturelle des Poissons.

Leptocephali of the ten-pounder reach a length of 40-45 mm. S. L. before beginning to shrink during metamorphosis, and shrink to about 20 mm. S. L. before length begins to increase again. Comparison of the leptocephalus in question with ten-pounder leptocephali of similar size, and comparable stage of development, shows a remarkable similarity in general form. Comparison of Harrington's figure 5 of his 16.0-mm. S. L. transitional stage of the tarpon with my 24.7-mm. S. L. mid-metamorphic larva of the ten-pounder (Gehringer, *in press*) also shows a superficial similarity. Comparison of these specimens and figures convinces me that, as with the offshore leptocephali of the ten-pounder, we have fortunately found an offshore leptocephalus of the tarpon. The length the leptocephalus of the Atlantic tarpon attains before beginning to shrink is unknown, but the East Indian tarpon, *Megalops cyprinoides* (Broussonet), was reported by Chidambaram and Menon (1948) as shrinking from about 30 mm. down to 17 mm. during metamorphosis, in laboratory experiments. Alikunhi and Rao (1951) reported *M. cyprinoides* leptocephali of 28 to 30 mm. shrank to as small as 16.5 mm. during metamorphosis, also in laboratory experiments. They cite a report by Bal and Pradhan (1947) of metamorphosing larvae of *M. cyprinoides* 13.5 mm. long. It is reasonable to assume that my leptocephalus would have had to increase in length and development before shrinking to the size and stage of development exhibited by Hildebrand's and Harrington's metamorphic larvae.

Van Kampen (1908, 1928) figured a 25-mm. total length (22 mm. "without caudal") *M. cyprinoides,* showing well-developed fin rays, an air bladder, and rudimentary pelvic fins. This is reputed to be the first published illustration of a tarpon "leptocephalus." Delsman's (1926) figure of a 29-mm. total length (about 26.5 mm. in S. L.) *M. cyprinoides* also shows a developing air bladder, pelvic fins; but with *all* rays of dorsal, anal, and caudal fins branched (this is considered an inaccuracy of the illustrator). Figured in the Bulletin of the International Oceanographic Foundation (Anonymous 1955) is the "leptocephalus" of the Atlantic tarpon, *M. atlanticus* (no size given), having well-developed dorsal, anal, and caudal fins, with pelvics also present. Holstvoogd (1936) figures a series of metamorphosing *M. cyprinoides* in which the earliest stage larva, about 20 mm. S. L., has a well-developed air bladder. I believe my specimen to be in the initial stage of length increase because it does not exhibit the development evidenced in these various larvae (metamorphic larvae by my definition).

The Marine Laboratory of the University of Miami collected eggs suspected of being those of the Atlantic tarpon, *M. atlanticus,* and maintained them through hatching and to larvae of 3.45 mm. standard length, or about 48 hours beyond time of hatching, before they died (Ellis, 1956)—duplicating earlier experiments by Breder (1944), whose larvae reached 2.9 mm. at 43 hours, but which shrunk to 1.9 mm. at 72 hours before dying (shrinkage is not explained). There have been no successful attempts to carry the egg through to a leptocephalus identifiable as that of the tarpon. Ellis (1956) speculated that after hatching the tarpon leptocephalus may move offshore with the currents and spend its early life as an open-ocean planktonic form. The leptocephalus taken on the *Gill* cruise lends evidence to this speculation.

Description of Preserved Specimen

Figure 1

Head: Triangular in dorsal aspect and compressed dorso-ventrally, wider than body, translucent with brain clearly visible; nostrils, shallow depressions; eyes large and oval; teeth, one fang-like tooth anteriorly on each side of upper jaw larger than remaining 4 in upper jaw and 5 in lower jaw.

Body: Uniformly thin, deep (ribbonlike), translucent with 55-57 body myomeres easily discernible with transmitted light (last few in caudal are indistinct); central nerve cord visible; vertebrae developing in caudal portion; digestive tract a tube appended to ventral margin of myomeres, anus opposite 41st myomere; air bladder a slight dorsal swelling in digestive tract at 23rd myomere; kidney dorsal to digestive tract at 35th to 41st myomeres.

Fins: Dorsal and anal finfold frayed with only ray bases formed, 12 dorsal and 21 anal, dorsal ray bases opposite 39th to 42nd myomeres and anal bases opposite 42nd to 48th myomeres, predorsal finfold small (fig. 1); caudal fin with 10 + 9 principal rays and 1 ventral secondary ray (none branched), hypural plates discernible with transmitted light, urostyle prominent; some finfold at caudal peduncle, but no preanal finfold as is found in *Elops saurus* (Gehringer, *in press*); pectoral fin a rounded bud with no rays developed; no pelvic fin.

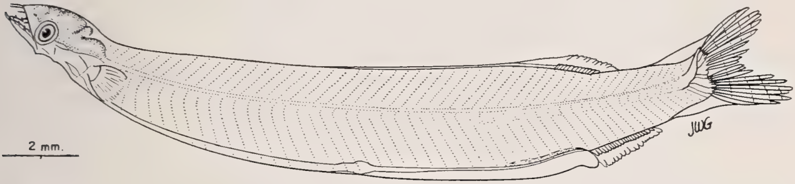

Figure 1. Leptocephalus of the Atlantic tarpon, *Megalops atlanticus* Valenciennes, 18.0 mm. in standard length.

Selected measurements: All measurements were made with aid of binocular microscope and micrometer eyepiece: Standard length, 18.0 mm.; total length, 19.7 mm.; head length, 2.40 mm.; length of lower jaw, 1.43 mm.; eye diameter (horizontal), 0.38 mm.; distance from snout to dorsal fin (anterior ray base), 13.1 mm.; distance from snout to anal fin (anterior ray base), 13.8 mm.; depth of head (at angle of jaw), 1.18 mm.; body depth at pectoral fin, 1.27 mm.; body depth at air bladder, 2.54 mm.; length of anal base, 1.56 mm.; length of dorsal base, 1.14 mm.

I wish to acknowledge the helpful suggestions and criticisms offered by William W. Anderson, Frederick H. Berry, David K. Caldwell, and Hugh M. Fields during the preparation of this manuscript.

Literature Cited

ALIKUNHI, K. H., and S. NAGARAJA RAO.
1951. Notes on the metamorphosis of *Elops saurus* Linn. and *Megalops cyprinoides* (Broussonet) with observations on their growth. *Journal of the Zoological Society of India,* 3(1): 99-109, 2 text-figs.

ANONYMOUS
1955. Opening the door to discovery. *Bulletin of the International Oceanographic Foundation,* 1(3): 44-47.

BAILEY, REEVE M.
1951. The authorship of names proposed in Cuvier and Valenciennes' Histoire Naturelle des Poissons. *Copeia,* 1951(3): 249-251.

BAL, D. V., and L. B. PRADHAN.
1947. Investigation of fish eggs and larvae from Bombay waters; Third Progress Report; 1946-47. *Department of Zoology Royal Institute of Science,* Bombay. [not seen]

BREDER, C. M., JR.
1944. Materials for the study of the life history of *Tarpon atlanticus. Zoologica,* 29(19): 217-252, text-figs. 1-9.

CHIDAMBARAM, K., and M. DEVIDAS MENON.
1948. Notes on the development of *Megalops cyprinoides* and *Hemirhamphus georgii. Proceedings of the Zoological Society of London,* 117: 756-763, figs. 1-9.

DELSMAN, H. C.
1926. Fish eggs and larvae from the Java Sea (10. On a few larvae of empang fishes). *Treubia,* 8(3-4): 400-412, 17 figs.

ELLIS, ROBERT W.
1956. Tarpon cooperative research program progress report. Report to Florida State Board of Conservation by The Marine Laboratory, University of Miami, July, 1956, 13 pp. (mimeographed).

GEHRINGER, JACK W.
In press
Early development and metamorphosis of the ten-pounder, *Elops saurus* Linnaeus. U. S. Fish and Wildlife Service, *Fishery Bulletin.*

HARRINGTON, ROBERT W., JR.
1958. Morphometry and ecology of small tarpon, *Megalops atlantica* Valenciennes from the transitional stage through onset of scale formation. *Copeia,* 1958(1): 1-10, 5 figs., 2 pls.

HILDEBRAND, SAMUEL F.
1934. The capture of a young tarpon, *Tarpon atlanticus,* at Beaufort, North Carolina. *Copeia,* 1934(1): 45-46.
1943. Notes on the affinity, anatomy, and development of *Elops saurus* Linnaeus. *Jour. Wash. Acad. Sci.,* 33(3): 90-94, figs. 1-3.

HOLSTVOOGD, C.
1936. The development of the mesonephros in some teleosts. Proefschrift, Universiteit van Amsterdam. Meijer's Boek—en Handelsdrukkerij—Wormerveer, xvi+98 pp., 14 figs., 35 photographs.

VAN KAMPEN, P. N.
1908. Die larve von *Megalops cyprinoides* Brouss. *Bulletin du Department De l'Agriculture aux Indees Neerlandaises,* No. 20, pp. 10-12, 1 fig.
1928. The larva of the East Indian tarpon, *Megalops cyprinoides* Brouss. [Translation of 1908 publication, from *Beneath Tropical Seas* by William Beebe, G. P. Putnam's Sons, New York-London, pp. 228-229]

AMEBAS OF WARM MINERAL SPRINGS, FLORIDA, INCLUDING *Cochliopodium papyrum* N. SP.[1]

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About twelve miles southeast of Venice, Florida, and three-fourths of a mile east of U. S. Highway 41, a warm brackish spring of major size, known as Warm Salt Springs (Ferguson, et al., 1947), and commercially as Warm Mineral Springs, empties by way of a two-mile-long creek into the Myakka River near the southern border of Sarasota County. The rapid rate of flow, (seven to nine million gallons of water per day) a constant temperature of 86° F., and an unusual concentration of salts present a formidable habitat for microorganisms. Ferguson, et al. (1947), Odum (1953), and Lackey (1957) have published data indicating the dissolved mineral content to be about half that of sea water in total dissolved solids (17,998 ppm. as compared to 34,482 ppm.), chloride (9,350/18,980 ppm.), sodium (4,973/10,556 ppm.), and magnesium 567/1,272 ppm.). The spring contains about two-fifths the potassium found in sea water (151/384 ppm.); but one-third more calcium (596/400 ppm.), six times more silica (24/4 ppm.), and four and one-half times more iron (0.09/0.02 ppm.). Sulfate content is about two-thirds that of sea water (1,704/2,639 ppm.). There is a total phosphorus content of 0.050 ppm., and an inorganic phosphorus component of 0.033 ppm. (Odum loc. cit.). Lackey (loc. cit.) reports there is no dissolved oxygen. He records 0.162 ppm. of hydrogen sulfide; a slightly alkaline pH of 7.2; and a chemical oxygen demand of 813 ppm. Thus, while approximately half as "salty" as sea water, the salt content is different in balance, and presents difficult problems of osmoregulation to any animalcule immersed in it.

Lackey (loc. cit.) cites ciliates as a numerous fauna, though of an unusual association of species. He further states that amebas and flagellates are "poorly represented". He implies either a paucity of different species or a limited number of individuals, or both, though he does not say. He mentions as flagellates one green

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[1] Work supported by grant-in-aid E-1158 from the National Institutes of Health; and the Department of Biology, University of Florida.

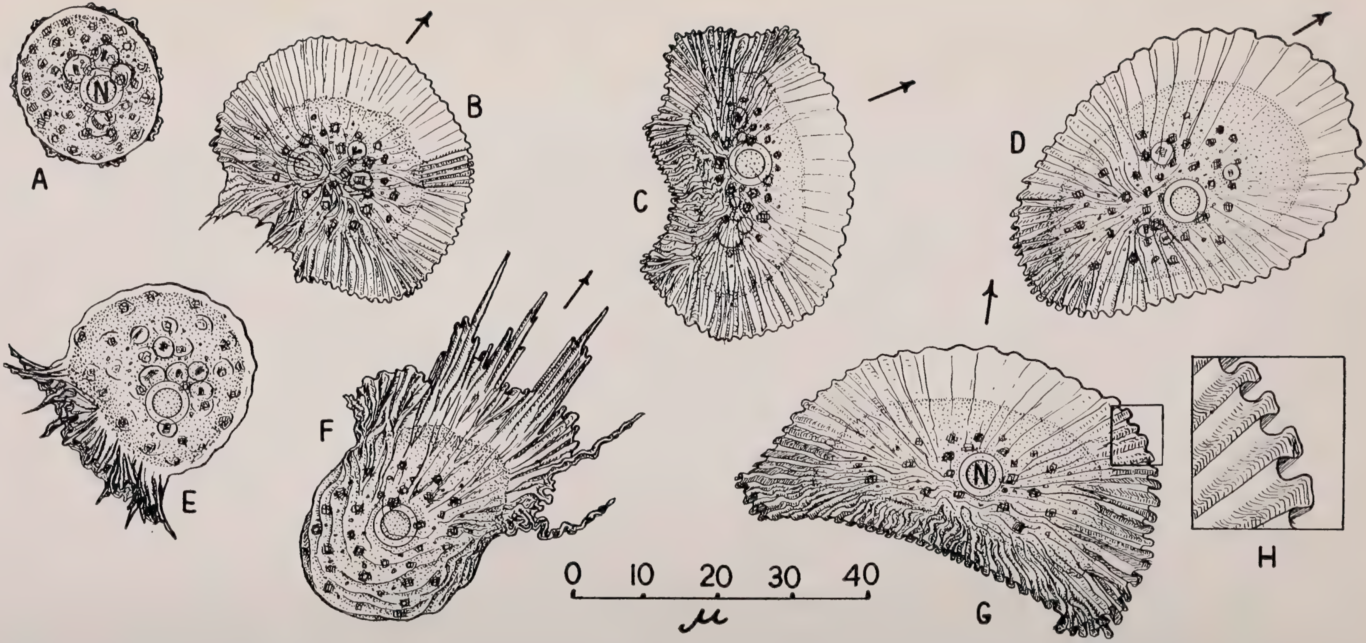

Figure 1. (A) *Cochliopodium papyrum* n. sp., inactive. (B) In slow locomotion, showing the typical corrugated folds of the clear border. (C) In moderately rapid locomotion, beginning a turn to its left, as evidenced by the pronounced corrugations at the left border. (D) In moderately rapid advance just after a turn, the ameba moving in the direction of its long axis. (E) A floating individual, seen laterally, and showing the much contracted and folded clear border. (F) Same individual as in (E), just after descent from afloat and during slow movement just prior to locomotion. The folded pseudopodal extensions of the clear wave are temporary. (G) *Cochliopodium papyrum* n. sp. in very rapid progress, fan-shaped and with the upper surface much wrinkled. (H) An enlargement of the area outlined in (G), showing in detail the folding of ectoplasm composing the clear, bordering wave. (N) is the nucleus; other spherical inclusions being food vacuoles. The irregular inclusions are the amorphous crystals. There is no contractile vacuole. Arrows indicate direction of movement.

and several colorless euglenoids. He names no amebas, though implying their presence.

Three water samples taken from Warm Mineral Springs on December 28, 1957, were examined repeatedly by brightfield and interferometer microscopy during a period of two weeks thereafter. Five species of amebas, known previously from marine waters, were found to have invaded and currently inhabit the springs. Three of these were named and carefully described by Schaeffer (1926) in his monograph. They are: *Flabellula mira; Flabellula* (Rugipes) *vivax*; and *Trichamoeba sphaerarum*. A fourth ameba is morphologically identical with *Vexillifera telmathalassa* (Bovee, 1956).

The fifth was tentatively identified as belonging to the genus *Hyalodiscus* Hertwig and Lesser (Bovee, 1958 a and b), but later comparisons clearly place it in the genus *Cochliopodium* Hertwig and Lesser (1874). A search of the literature indicates that it is a new species. It will be hereinafter described.

In two of the water samples, amebas were scarce; but in the third, the species named above were present in abundance in an algal-sulfur bacteria-ciliate association taken where the overflow of the main spring flows into the creek.

Though only five species of amebas have been found in the Warm Mineral Springs, large numbers of individuals may be present in some localized, ecological associations. The scarcity of amebas mentioned by Lackey (loc. cit.) seems to refer principally to the number of species more than to the number of individuals.

It is evident, also, that the species of amebas which live in the spring are physiologically tough and adaptive, capable of extensive osmoregulation, and already so, probably, before entering the spring. *Flabellula mira* is an ubiquitous animal, found in marine waters (Schaeffer, 1926), in brackish and fresh waters (Bovee, 1953 and 1958a), and able to survive transfer to distilled water or to sea water ten times concentrated by evaporation (Hopkins, 1938). *Flabellula* (Rugipes) *vivax* occurs naturally in a variety of marine and brackish water situations (Bovee, 1958a).

Vexillifera telmathalassa withstands changes in salt concentrations due to evaporation and rainfall, and the daily temperature changes in exposed tide pools. A very similar species occurs naturally in fresh waters a few miles inland from the sea (Bovee, 1950 and 1958b).

Trichamoeba sphaerarum is strictly marine according to Schaeffer (1926), dying quickly in sea water diluted 50% with distilled water. The morphologically identical organism in the Warm Mineral Springs must therefore have undergone considerable adaptation.

How the amebas originally entered the spring is not known, but the frequent presence of gulls and crows at the spring suggests that the amebas may have survived transfer in mud on the feet of these birds. Immigration upstream from the sea is also possible, but seems less likely. Subsurface transfer in underground seepage is unlikely since soundings of the spring indicate more than 167 feet of depth (Ferguson et al., 1947).

Cochliopodium papyrum n. sp.

General contours: The ameba is ovate to subspherical at rest, with a thick ectoplasm resembling a pellicle, the surface of which is somewhat wrinkled and papulate. In slow movement the ovate body flattens, and the pellicle extends as a wrinkled skirt-like periphery about half the width of the central mass. In beginning locomotion the clear border at one "side" is extended as a series of crinkled, conical, clear pseudopods. As locomotive speed increases, the body becomes ovoid and the clear border more pleated. At greatest speed of advance, the body is fan-shaped anteriorly and almost straight to slightly concave at the rear border, the upper surface and clear border being much wrinkled, resembling a crinkled mass of paper. No radiate stage was seen.

Size: At rest the ameba measures 17 to 22 μ in long diameter, 14 to 18 μ in short diameter, and 10 to 7 μ in vertical diameter. During slow movement the body mass measures 15 to 20 μ in diameter, and the total diameter across the body mass and surrounding clear wave, 35 to 40 μ. In slow locomotion the posteriorly placed, body mass is subspherical, 25 to 32 μ in horizontal diameter, the anterior, clear border being 7 to 10 μ in extent, and the pseudopods 4 to 25 μ long, overall length 50 to 60 μ. While the ameba is in moderate locomotion, the body mass measures 25 to 35 μ in width, and 15 to 25 μ in length, the surrounding border being 7 to 10 μ wide, and the overall length 35 to 40 μ, with overall width being 44 to 55 μ. The central body mass during rapid advance is

10 to 15 μ measured antero-posteriorly, and 24 to 28 μ measured laterally, the surrounding clear wave extends 7 to 10 μ anteriorly and laterally, and 4 to 6 μ posteriorly. The overall length is 20 to 25 μ and overall width 37 to 45 μ.

Color: Practically colorless, this organism borrows the colors of its ingested food, which is mainly plant detritus, so that the body mass may appear to contain brownish or yellowish droplets, greenish fragments, and many pale yellowish-green amorphously-crystalline inclusions. The protoplasm is nearly colorless with perhaps a slight bluish tint when observed by brightfield microscopy, and is a pale reddish purple by interferometric dark-contrast phase microscopy.

Locomotor organelles: Pseudopods are not regularly formed by this ameba. Only in slow locomotion do extensions of protoplasm resembling pseudopods appear. These are extensions of the anterior margin of the surrounding clear wave which are 3 to 25 μ long, tapering, conical, crinkled and folded lengthwise, being almost pointed at the tips, and 3 to 6 μ wide at their bases. When the organism is disturbed and goes afloat similar pseudopodal structures may develop.

In more rapid locomotion the clear wave is generated by outflow of protoplasm midway along the anterior border, being displaced laterally by more outflow. The laterally pushed elements of the wave fold in linear corrugations from body mass to the edge of the wave. These fold more and more tightly together until they reach the posterior border of the ameba. There the parallel folds crinkle and contract along their lengths, and meld back into the general body mass.

Rate of Locomotion: This ameba is torpid much of the time, and slow in its movements when active. When disturbed it may go afloat, with the ectoplasmic wave much folded and crinkled about the previously ventral portion of the body. Upon descent to the substrate it remains inactive for an hour or more before beginning to move about, even under rather intense illumination. In its most rapid progress along a rather sinuous path, it advances only about half its antero-posterior extent in one minute, about 20 μ. It is most active in mid-day hours, very rarely active in early morning or late afternoon hours, moving slowly amongst bacterial floc and algae on the bottom of the stream.

Uroidal Structures: These semi-permanent, posterior, gelated structures or tufts of filaments do not develop in the activities of this ameba.

Surface Markings: At rest, and during slow movement and locomotion, amorphous crystalline inclusions rest just under the thick pellicular membrane, causing it to bulge slightly over each crystal so that the surface appears somewhat papulated. In more rapid movements, the clear margin is pleated and the dorsal surface of the body mass thrown into wrinkles and folds which are more or less continuous with the marginal folds.

Nucleus: This organelle is usually approximately central in the body mass. It is pale and difficult to see clearly. Light passing through it is not strongly and differentially refracted, so that the nuclear membrane is not clearly discerned; that of the nuclear endosome being more distinct. The nucleus is 6.5 μ in diameter, spherical in form. The endosome is central within the nucleus, also spherical, very pale, but with a slight bluish tinge under brightfield microscopy, and pale bluish-purple under interferometer-phase microscopy, measuring 4 μ in diameter.

Crystals and Granules: About two dozen irregularly crystalline particles from less than one micron to about 3 μ in diameter are present, located mostly in the gelated protoplasm just beneath the thick, pellicular ectoplasm which covers the body mass. These appear pale yellowish-green under brightfield microscopy, and dark purple with yellowish "highlights" under interferometer, dark-contrast phase microscopy. Also present are many tiny granules less than 0.5 μ in diameter which give the endoplasm a pale bluish tint under brightfield and a reddish-purple color under dark-contrast phase.

Food Vacuoles: Several of these are usually visible, containing bits of vegetable detritus in various states of digestion. The vacuoles vary in size from about one micron in diameter to about 5 μ in diameter, greenish to orange in color under brightfield and yellowish to reddish-orange under phase microscopy. They form beneath the body mass as the ameba glides over the food particle.

Contractile Vacuoles: None are present.

Habitat: A brackish spring, 86° F., Warm Mineral Springs, Sarasota County, Florida.

LITERATURE CITED

BOVEE, E. C.

1950. "Some Observations, Based on the Use of the Phase Microscope, Concerning the Taxonomy and Morphology of Certain Free-living Amoebas". Ph.D. Thesis, University of California at Los Angeles.

1953. "The Presence of the Contractile Vacuole in *Flabellula mira* in Fresh Water." Proc. Soc. Protozool. 4: 15. (abst.).

1956. "Some Observations on a Marine Ameba of Intertidal Zones, *Vexillifera telmathalassa* n. sp." J. Protozool. 3: 155-158.

1958a. "Progress Report to the National Institutes of Health, Research Grant E-1158." (mimeographed).

1958b. "Some Amebas of Warm Mineral Springs, near Venice, Florida." ASB Bull. 5(1): 4 (abst.).

FERGUSON, G. E., C. W. LINGHAM, S. K. LOVE, and R. O. VERNON

1947. "Springs of Florida." Geol. Bull. No. 31, Fla. State Dept. of Conservation, Fla. Geol. Survey, Tallahassee.

HERTWIG, R., and E. LESSER

1874. "Ueber Rhizopoden un denselben nahestehende Organismen." Arch. f. Mikros. Anat. 10(suppl.): 1-243.

HOPKINS, D. L.

1938. "Adjustment of the marine amoeba, *Flabellula mira* Schaeffer, to changes in the total salt concentration of the outside medium." Biol. Bull. 75: 337 (abst.).

LACKEY, J. B.

1957. "A New Large Ciliate from Warm Mineral Springs." Quart. J. Fla. Acad. Sci. 20(4): 255-260.

ODUM, H. T.

1953. "Dissolved Phosphorus in Florida Waters." Report of Investigations, No. 9, Fla. State Dept. of Conservation, Fla. Geol. Survey, Tallahassee.

A SMALL FOSSIL HERPETOFAUNA FROM BARBUDA, LEEWARD ISLANDS, WITH THE DESCRIPTION OF A NEW SPECIES OF *HYLA*[1, 2]

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In the summer of 1958 I was afforded the opportunity of prospecting for vertebrate fossils on Barbuda, British Leeward Islands. During the course of this investigation two caves were found to contain numerous fossilized remains of vertebrate animals, some of which are now extinct. This report deals with only the reptiles and amphibians. Reports on the other vertebrate groups will appear at a later date.

The island of Barbuda is located about 40 miles north of Antigua and east of the main transportational routes of the Lesser Antilles, so that it is infrequently visited by biologists. It is a rather small island, composed almost entirely of a soft, massive Miocene limestone that is riddled with solution pockets, sinkholes and small caves. Physiographically the island can be divided into two areas: (1) the Lowlands, comprising about one half of the total area, is a terraced region ranging from sealevel to about 30 feet, and (2) the Highlands, a terraced area along the southern and eastern coasts, ranging in elevation from about 60 to 200 feet. Almost all of the sinks and caverns are found in this area. Along the southeastern coast the sea has eroded away part of the Highlands, so that a high cliff several miles long has been formed along the shore. The cliff is particularly well developed near Two Foot Bay, where it reaches a height of almost 100 feet. Here the base of the cliff has many small caves produced by a transgressing Pleistocene sea. In addition, the erosion of the cliff exposed many sinkholes and caves produced in the higher terrace at a much earlier time. The deposits formerly contained in these older caves (indicated by small patches of reddish breccia on the walls) have been largely swept out during a period of high sea level. The regressing sea exposed the eroded caverns and they again served as traps for animal re-

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[1] A contribution from The Department of Biology and The Florida State Museum.

[2] Field work supported by National Science Foundation Grant G-3896, and The Florida State Museum.

mains. It is in these presumed secondary deposits that the fossil herpetofauna was discovered.

The caves from which the bones were removed are at an elevation of about 30-50 feet above sea level. The elevation of the terrace at the foot of the cliff is about 30 feet. The terrace level may thus be contemporaneous with the Pamlico terrace of southeastern United States. The Pamlico deposits in North America are generally believed to have been laid down during Mid-Wisconsin time. The fossils deposited in the soft, fine, highly phosphatic reddish soil of the caves of Barbuda are thus, in all likelyhood, Post Mid-Wisconsin. No *Rattus* were found with the bones, indicating a Pre-Columbian age as the younger limit.

Fossil veterbrates were found in only two caves at Two Foot Bay, though many more were examined. In both instances the bones were in a loose reddish soil a few inches below a very recent accumulation of black to brown earth containing feathers and *Rattus*. Most of the caves in the area contained very little soil. When present it was usually found in smaller crevases and solution holes above the floor of the caverns or shelters. The stratigraphy of the earth in one of the small caves containing fossils follows:

Stratigraphy at Cave I, Two Foot Bay, Barbuda

4. Recent black to brown earth, containing feathers and white to yellow non-mineralized bones of bats and *Rattus* . . . . 1-3 inches
   Unconformity, indicating loss of at least some of the record.
3. Fine, soft, highly phosphatic reddish brown to red soil containing a large number of bones which are dark brown and heavily mineralized . . 4-18 inches
2. Light red to yellow slightly phosphatic soil, containing fewer bones, but which are also dark brown and heavily mineralized . . . . 6-10 inches
1. Limestone

Most of the vertebrate material reported on in the present paper originated from bed 3. *Megalomys*, a rodent now extinct on Barbuda, was found only in beds 2 and 3. Cave I contained largely smaller vertebrates and is undoubtedly an old owl pellet deposit.

Cave II contained large numbers of *Megalomys* of all sizes and fewer reptiles, amphibians and bats, indicating that the fissure may have been used as a den. In addition, many of the bird bones from this locality seem to represent only a few individuals, so that it may also have been used as a nesting site from time to time.

An analysis of the fossil herpetofaunal material now available from these two localities follows.

AMPHIBIA

The only extant amphibian genera known from the Leeward Islands are *Bufo*, *Leptodactylus* and *Eleutherodactylus*. It is thus interesting that the fossil frog material from Barbuda clearly belongs to a fourth genus. On the basis of many characters it is obvious that the extinct form belongs to the genus *Hyla*. No living species of this genus occur within 500 miles of Barbuda. In the Greater Antilles several forms are known from as far eastward as Hispaniola. To the south the closest records are from Trinidad and Tobago. The St. Lucia record is presumably based on an introduction (Barbour, 1937), though this has not been adequately proven. The relationships of the extinct Barbuda form seem to lie with the Trinidad species, rather than with those from the Greater Antilles. However, not all of the Hispaniolan species have been available for study, as some are quite rare in collections.

The fossil form is referred to the genus *Hyla* on the basis of the lack of a ridge on the dorsal surface of the shaft of the ilium (as is found in *Rana*, *Eleutherodactylus*, *Leptodactylus*, etc.) and the lateral development of the protuberence of the dorsal prominence of the same element. The Bufonidae are usually provided with a well developed dorsal prominence, but the protuberence, if present, is directed dorsally rather than laterally.

In all of the Greater Antillean species of *Hyla* which I have examined the dorsal prominence is directed dorsally. In all of the Trinidadian species the process is bent laterally towards the external surface of the element. The protuberence is placed at the truncated edge of the prominence and also directed laterally. The fossil ilia have been compared with a number of Trinidadian and northern South American hylids and were found to be quite distinctive, forming the basis of the description of a new and extinct species of Lesser Antillean *Hyla*.

Hyla barbudensis new species

Holotype:—University of Florida Collections 2572, a complete ilium, collected July 3, 1958, by Walter Auffenberg and Wayne King.

Type Locality and Horizon:—Cave I, Two Foot Bay, Barbuda, British Leeward Islands; Late Pleistocene or Recent.

Referred Specimens:—UF 2753, eight ilia; UF 2755, various limb elements and one dorsal vertebra; UF 2754, two dentaries. All of this material was collected from the same locality and horizon as the holotype.

Diagnosis:—A small species of extinct *Hyla* from Barbuda, differing from *Hyla maxima, H. lanciformis* and *H. punctissima* in being much smaller, and in having a greater angle between the ilial shaft and the anterior edge of the ventral portion of the acetabular expansion. From all of the smaller Trinidadian and northern South American species of *Hyla* I have examined (*H. leucophyllata, H. punctata, H. goughi, H. rubra*) it differs in having a greater angle between the shaft of the ilium and the ventral portion of the acetabular expansion, in having the anterior and posterior edges of the ventral portion of the acetabular expansion nearly parallel, and in having the posterior portion of the dorsal prominence directly above the anterior edge of the raised margin of the acetabulum, rather than posterior to the edge.

The nature of the differences between the extinct species and the recent species examined suggests that although it is related to the South American members of the genus it is distinct and a really close relationship to a particular species cannot be demonstrated at this time. Until much more is known concerning the taxonomy and osteology of the Recent hylids of South America it seems best to defer a comparison with all of the forms until a later date.

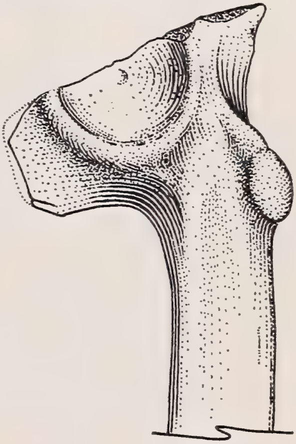

Figure 1. *Hyla barbudensis* new species, Holotype right ilium (UF 2572); Cave I, Two Foot Bay, Barbuda, British Leeward Islands; Late Pleistocene or Recent.

Description of the Type:—A complete left ilium. Shaft only slightly curved, without a dorsal crest. Dorsal prominence low, long, directed externally, with a well developed somewhat elongated protuberance, also directed laterally, the posterior edge above the anterior raised edge of the acetabulum. Acetabulum rounded. Acetabular expansion broad ventrally, with a greater vertical distance anteriorly than posteriorly, the anterior and posterior edges nearly parallel. The ventral edge of this process almost straight, not an obtuse to acute angle as it is in most hylid frogs.

Variation:—The remaining ilia vary only slightly in size. The most conspicuous variable feature is the shape of the dorsal protuberence. It varies from a structure almost perfectly round to one which is greatly elongate. Its position is identical in all of the specimens. Where present the ventral portion of the acetabular expansion is similar to that described in the holotype.

Reptilia

Thecadactylus rapicaudus

Many jaw, cranial and postcranial elements (UF 2809) from Cave I are referred to this species of large gekkonid lizard. The size of the elements, number and shape of the teeth, etc., of the fossils are indistinguishable from Recent skeletons of the same species. It occurs on Barbuda at the present time.

Of particular interest is the fact that this lizard occurs as a fossil in the Lesser Antilles at all. It has been assumed by some workers to have been transported by man from one island to another. While this may be true, the presence of fossils of this species on Barbuda in a deposit of presumed pre-human occupancy of the island suggests that the genus was widespread at the end of the Pleistocene, having extended its range northward from South America and Trinidad along the Lesser Antillean chain long before this time.

Ameiva griswoldi

A single left dentary from Cave II (UF 2760) is the only element definitely referrable to this genus. It differs in no regard from that of an average-sized specimen of this species, to which it is tentatively referred. However, closely related species on other islands of the Leeward group are apparently inseparable from *A. griswoldi* on the basis of osteological material alone. The species is found on Barbuda at the present time, being one of the most abundant lizards encountered in the field during our visit there. It seems reasonable to refer the fossil to the same genus and species, at least for the present.

Anolis leachii

A very large number of dentaries maxillaries, frontals and various other elements are referred to this genus and species (UF 2756-7). Most of the fossil material representing this form was taken from Cave I, though some elements were also found in Cave II.

Of the species of *Anolis* found on Barbuda today, *leachii* is by far the largest. Medium to large specimens are provided with a considerably roughened area on the external ventral surface of the dentary. It occurs in both sexes, but becomes very pronounced in the older males. It is lacking in the dentaries of the second, and smaller species found on the island at the present time—*A. wattsi.* All of the larger fossil dentaries are provided with this heavily roughend area, so that correct specific identification is assured in at least these specimens. The shape and number of the maxillary teeth, and the shape and sculpturing of various available cranial elements of the fossil form is identical to that in *A. leachii.*

Unfortunately, *A. wattsi* cannot be separated from younger specimens of *A. leachii* on any osteological basis known to me. Some of the smaller dentaries available from the Two Foot Bay caves may belong to *A. wattsi*, but they are not distinguishable.

Pseudoboa cf. *P. cloelia*

Two snake vertebrae (UF 2761) are available from Cave I. It is of interest that these vertebrae do not represent *Alsophis,* the only terrestrial snake genus found in the Leeward Islands today. They are not referrable to *Dromicus,* a genus found on Guadeloupe and some of the Greater Antillean islands. They can in no way be construed as being even an extinct relative of any of the remaining genera of snakes of the Greater Antilles.

The elements differ from those of *Alsophis* and *Dromicus* in many regards, chief of which is the fact that the neural spine is much higher and longer than in these genera, and the centrum is much shorter. They have been compared with all of the remaining Antillean snake genera with the exception of *Darlingtonia,* a rare Hispaniolan genus. It differs greatly from all of these with the exception of *Pseudoboa* to which it seems closely related.

Unfortunately, the vertebrae are not from a fully adult specimen so that it is not possible to determine to which of the two northern South American species of *Pseudoboa* the fossil belongs. The vertebrae bear no strong resemblances to those of the remaining colubrid snakes from Trinidad. They differ from those of *Pseudoboa cloelia* and *P. neuweidii* available for study in being smaller and having a proportionately shorter centrum. However, juvenile and subadult snakes frequently have shorter centra than do adults of the same species, so that the differences are not beyond what might be expected during ontogenesis.

Except for Leptotyphlops, there are no other snakes on Barbuda at the present time. *Alsophis leucomelas* is still found on Montserrat, Antigua and Guadeloupe (Barbour, 1937; Dunn, 1934). Antigua and Barbuda are on the same bank. Whether or not *Alsophis* occurred on Barbuda in the past is, of course, unknown, though it seems logical to assume that it did. The presence of *Pseudoboa* on Barbuda suggests that the present range of many of the reptiles in the Lesser Antilles may have been somewhat restricted near the end of the Pleistocene. It also attests to the movement of South American herpetofaunal elements northward throughout the greater part of the Lesser Antilles during the Pleistocene, as has been suggested in studies of various other animal groups.

LITERATURE CITED

BARBOUR, T.

1937. Third list of Antillean reptiles and amphibians. Bull. Mus. Comp. Zool., 82(2): 79-166.

DUNN, E. R.

1934. Physiography and herpetology in the Lesser Antilles. Copeia, 1934 (3): 105-111.

A NEW SPECIES OF THE BOARFISH GENUS *ANTIGONIA* FROM THE WESTERN ATLANTIC

Frederick H. Berry[1] and Warren F. Rathjen[2]
United States Fish and Wildlife Service

Specimens of boarfish of the genus *Antigonia* from the Western Atlantic that we have examined comprise two taxonomically distinct and variable forms. One of these is identified as *Antigonia capros* Lowe. This species fits the classical concept of *Antigonia* in having body depth generally greater than or equal to the standard length. The second form has body depth generally less than the standard length. It is described here as a new species.

The following description is in part extracted from a manuscript that has been accepted for inclusion in the Bulletin of the Florida State Museum, but that has been delayed in publication. The subsequent publication will contain biological data and more complete descriptions of the two Western Atlantic species of *Antigonia* and their relationships to each other and to nominal species of *Antigonia* from the Indo-Pacific. Paratypes have been distributed to or identified in the collections of the several museums listed below, and the description of the new species is published at this time to make the name available.

ANTIGONIA COMBATIA, new species

(Figure 1)

Diagnosis: [3] An *Antigonia* with dorsal spines 9 (rarely 10), dorsal softrays 29 (26 to 30), anal softrays 27 (23 to 28), pectoral I-12 (rarely I-11 or I-13), scale rows 53 (about 49 to 57), body depth 66.7 (100.8 to 62.4), third (longest) dorsal spine length 16.2 (30.2 to 16.2), first (longest) anal spine length 7.7 (16.2 to 7.7), pelvic spine length 12.4 (22.6 to 12.4), upper jaw length 9.0 (8.1 to 11.1).

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[3] The number after each character is the value recorded for the holotype. Numbers in parentheses following this are ranges in values of all specimens. Where the proportion decreases with growth, the larger extreme of the range is placed first. Body proportions are in percent of standard length (% S.L.). This procedure is followed in the Description.

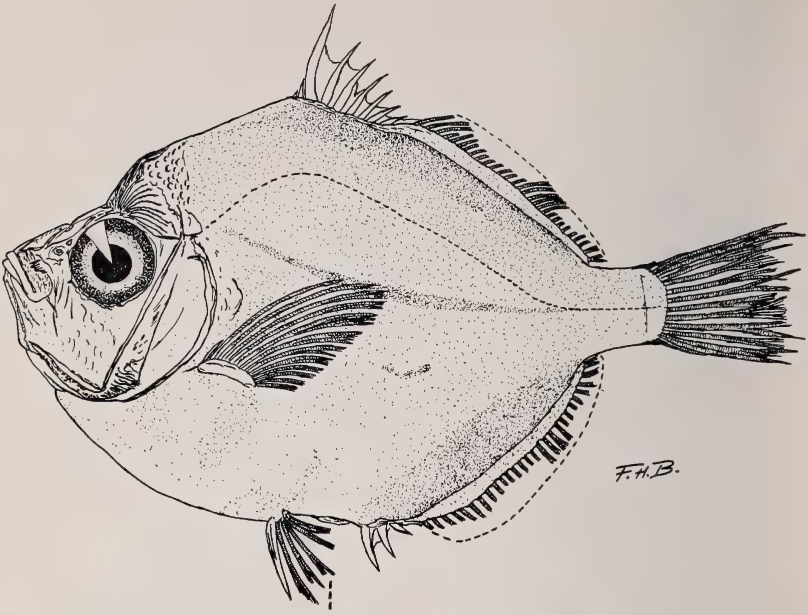

Figure 1. *Antigonia combatia,* holotype, USNM 159597, 117 mm. in standard length, *Combat* sta. 259, 24°29′ N., 83°28′ W., southwest of Tortugas, Florida.

Description: Body compressed and elevated. Greatest vertical body depth, 66.7 (100.8-62.4). Snout to 1st dosal spine, 50.0 (69.4-50.0). Snout to 1st anal spine, 68.8 (84.5-66.7). Depth of peduncle at caudal base, 12.0 (16.2-11.9).

Head length, 34.2 (43.4-34.2). Profile changing with growth; generally with an apex produced by upper end of supraoccipital crest, and concavities between apex and dorsal fin origin and between apex and snout, these concavities varying with growth stage and individuals. Snout length, 10.3 (12.5-9.9). Cleft of mouth angular; lower jaw slightly projecting. Upper jaw length, 9.0 (8.1-11.1). Eye diameter, 13.2 (20.4-13.2).

Gill rakers, 5 (3-5) + 16 (14-16). Branchiostegals, 6. Scale rows, 53 (about 49 to 57).

Dorsal spines, 9 (9-10); third spine the longest, its length, 16.2 (30.2-16.2). Anal spines, 3 (3); first spine the longest, its length, 7.7 (16.2-7.7). Dorsal spines connected to dorsal softrays and anal spines to anal softrays each by a shallow notched membrane. Dorsal softrays, 29 (26 to 30; modally, 28). Anal softrays, 27 (23 to 28; modally, 26). Anal fin base length, 44.4 (55.2-40.7). Caudal fin subtruncate; caudal principal rays, 6 + 6; caudal secondary rays, 4 + 3. Pectoral fin bluntly pointed; pectoral rays, I-12 (rarely, I-11 or I-13); pectoral length, 29.1 (40.4-28.5). Pelvic fin pointed; pelvic rays, I-5 (I-5); pelvic spine length, 12.4 (22.6-12.4).

Pigmentation essentially faded out on preserved specimens. A Kodachrome slide taken of several paratypes immediately after capture shows the dorsal aspects of the head and body to be reddish pink blending into pink on the sides and then into silver on the ventrolateral aspects.

Relationships: Because the relationships of the nominal species of *Antigonia* are presently uncertain and significant data on the intraspecific variations of only two of them (*A. combatia* and *A. capros*) are available, *A. combatia* is distinguished below from each of the nominal species by the characters we consider most significant. *A. combatia* differs from *A. capros* Lowe, *A. aurora* (Müller and Troschel), *A. steindachneri* Jordan and Fowler, *A. browni* Fowler, and *A. eos* Gilbert in having fewer dorsal and anal softrays (31 or more dorsal and 29 or more anal softrays in the other species) and in having a shorter pelvic spine (24 percent of standard length or greater in the other species). *A. combatia* and the remaining nominal species have generally similar numbers of dorsal and anal softrays. *A. combatia* differs from *A. rubescens* (Günther) and *A. fowleri* Franz in having a greater number of oblique scale rows (38 to 47 rows in *A. rubescens* and *A. fowleri*), and in having a shorter pelvic spine at comparable body sizes (from about 20 to 50 mm. S.L., 14 to 23% S.L. in *A. combatia,* 24 to 30% S.L. in the other species; above 50 mm. S.L., 12 to 20.9% S.L. in *A. combatia,* 21 to 26% S.L. in the other species). *A. combatia* differs from *A. rhomboidea* McCulloch in having a lesser body depth (about 106% S.L. in *A. rhomboidea*) and in having a shorter pelvic spine (about 26.4% S.L. in *A. rhomboidea*). *A. combatia* differs from *A. rubicunda* Ogilby in having a shorter 3rd dorsal spine (about 34% S.L. in *A. rubicunda*) and in having a shorter pelvic spine (about 28% S.L. in *A. rubicunda*). *A. combatia* differs from *A. malayanus* Weber in having one less dorsal spine (8 spines in all known specimens of *A. malayanus*) and in having a shorter upper jaw (about 12.5 to 14% S.L. in *A. malayanus*). [*Antigonia mulleri*

Klunzinger appears to belong to the family Zeidae. *Antigonia benhatatate* (Bleeker) is apparently a *nomen nudum*.]

Distribution: The holotype was taken off Tortugas, Florida. The paratypes were taken off Brazil (Amazon River), Surinam, British Guiana, Caribbean Nicaragua and Honduras, northern Cuba, Florida, North Carolina, and Massachusetts. Recorded depths of the trawl hauls in which most of the specimens were taken range from 65 to 325 fathoms.

Holotype: U. S. National Museum No. 159593, 117 mm. S.L., taken at COMBAT station 259, 24°29′ N., 83°28′ W., 7 March 1957.

Paratypes: Deposited in the following collections, U. S. National Museum; Chicago Natural History Museum; Academy of Natural Sciences of Philadelphia; Museum of Comparative Zoology; British Museum (Natural History); Museu Municipal do Funchal; Museu Nacional, Rio de Janeiro; Bingham Oceanographic Collection; University of Florida; Stanford University; Tulane University; University of Miami Marine Laboratory; Cornell University; Gulf Coast Research Laboratory; South Atlantic Fishery Investigations, Brunswick, Georgia. The 186 paratypes range in size from 118 to about 19 mm. S.L.

Derivation of the Name: Named for the M/V COMBAT, chartered by the U. S. Fish and Wildlife Service primarily for deepwater trawling exploration off the Atlantic coast of the southeastern United States. Collections made with this vessel are adding greatly to our biological knowledge of the area. COMBAT burned and sank off Mexico in December 1957.

Quart. Journ. Fla. Acad. Sci. (1958), 21(3), 1959.

STUDIES ON HELMINTH PARASITES FROM THE COAST OF FLORIDA. IV. DIGENETIC TREMATODES OF MARINE FISHES OF TAMPA, BOCA CIEGA BAYS, AND THE GULF OF MEXICO. 3 *

Franklin Sogandares-Bernal and Robert F. Hutton
Florida State Board of Conservation Marine Laboratory **

This contribution is a continuation of a series of studies on the diseases and parasites of marine and coastal animals which is currently being sponsored by the Florida State Board of Conservation.

Acknowledements are here extended to Dr. V. G. Springer, of this laboratory, for identification of some fish hosts.

Unless otherwise cited, all measurements are in millimeters.

Family Bucephalidae Poche, 1907

1. *Rhipidocotyle transversale* Chandler, 1935
(Figs. 1 to 2)

Host: *Strongylura timucu* (Walbaum) sp. inq.; needlefish; new host record?; family Belonidae
Incidence of Infection: In 1 of 3 hosts
Number: One
Location: Mid-intestine
Locality: Bayboro Harbor, Tampa Bay, Florida; new locality record

Discussion: The identity of the host reported above is in question. There appear to be two common species of *Strongylura* in Bayboro Harbor. The hosts collected in this study were the finer scaled of the two forms and in addition possessed scaled cheeks. The identification is consistent with common usage as by Kilby (1955) and Longley & Hildebrand (1941). Hopkins (1954) reported *R. transversale* from *Strongylura marina.* Since the identity of S. *marina,* S. *notata* and S. *timucu* is somewhat confusing, we cannot be absolutely sure of Hopkin's report as well as our own. So far as the literature is concerned, this report of *R. transversale* is apparently the first from *Strongylura timucu* and also represents a new locality record. According to Manter (1947), Linton's (1940) *Prosorhynchus gracilescens* from Woods Hole is *R. transversale*, a species whose known distribution now includes Massachusetts, Virginia, Florida, Louisiana and Texas.

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** Contribution Number 16 from The Fla. State Board of Cons. Marine Lab. Maritime Base, Bayboro Hrbr., St. Petersburg, Fla.

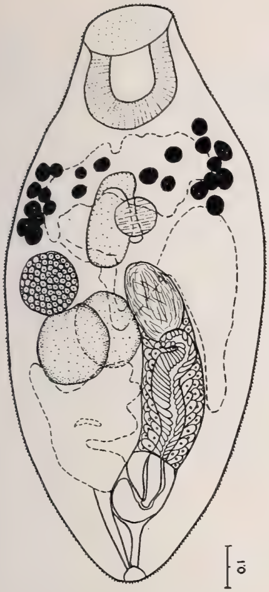
2. *Bucephaloides bennetti* Hopkins & Sparks, 1958
(Figs. 3 to 5)

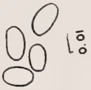
Host: *Paralichthys albiguttus* Jordan & Gilbert; gulf fluke; new host record; family Pleuronectidae
Incidence of Infection: In 2 of 2 hosts
Numbers: 2, 42
Location: Pyloric ceca
Locality: Tarpon Key, Boca Ciega Bay, Florida; new locality record

Discussion: Manter (1954a.: p. 2) and Hopkins & Sparks (1958) indicated that *Bucephalopsis bennetti* Melugin, 1940, was a *nomen nudum*. The species was described in a thesis by Melugin and later given a name in abstract but no description included. Hopkins & Sparks (1958) retained the specific name *bennetti* for this species of Melugin. Hopkins (1954) named the genus *Bucephaloides* for all species previously in *Bucephalopsis* and retained the latter genus for *B. haimeanus* La Caze-Duthiers, a larval form. *Bucephaloides bennetti* was originally described from *Paralichthys lethostigmus* a species which appears to morphologically differ from *Paralichthys albiguttus* only in finray count. Hopkins and Sparks (1958) apparently did not describe the "lip" (fig. 5) of *B: bennetti*. Manter and Van Cleave (1951) described a closely related species, *B. labiatus* from a flounder, *Paralichthys californicus*, as possessing such a lip-like structure associated with the mouth. It is of some interest to note that the "lip" associated with the mouth has only been reported in *Bucephaloides* spp. from flounders of the genus *Paralichthys* even though sometimes widely separated geographically.

3. *Bucephaloides caecorum* Hopkins, 1956
(Figs. 6 to 7)

Host: *Bairdiella chysurus* (Lacepede); silver-perch; family Sciaenidae





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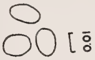

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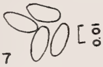

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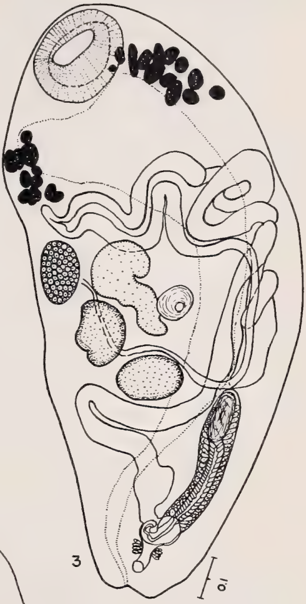

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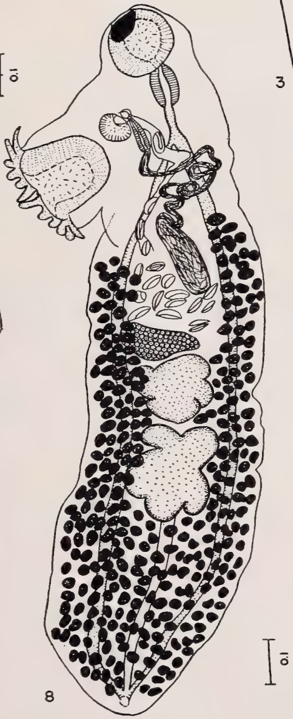

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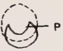

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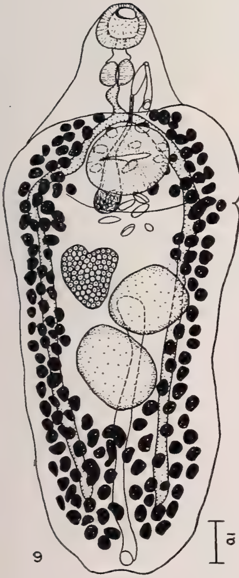

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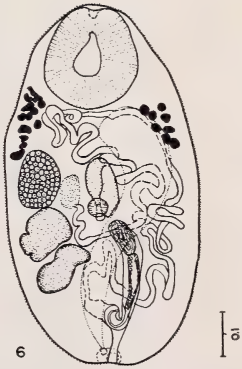

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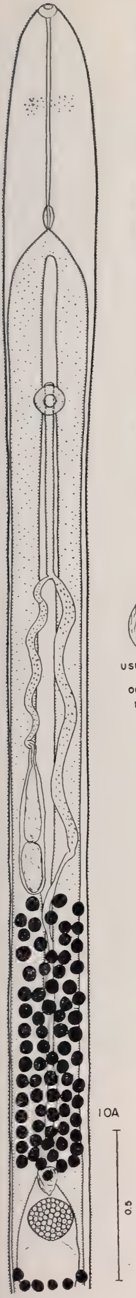
Incidence of Infection: In 1 of 9 hosts
Number: One
Location: Pyloric cecum
Locality: Tarpon Key, Boca Ciega Bay, Florida; new locality record

Discussion: *Bucephaloides caecorum* has been reported from *Cynoscion nebulosus* and *Bairdiella chrysurus* by Hopkins (1956). Sparks (1958) records the parasite from the same hosts and *Micropogon undulatus* in Grand Isle, Louisiana. *Bucephaloides caecorum* is possibly an accidental parasite of *B. chrysurus* judging from the number of hosts found negative combined with the finding of only one worm. *Bucephaloides caecorum* is similar to *B. bennetti*, a form from which it may be instantly separated by the fact that the uterus of the latter does not extend so far anteriorly, the oral sucker is proportionately smaller, and an oral "lip" is present.

EXPLANATION OF FIGURES

Unless otherwise stated, all figures were drawn with the aid of a camera lucida. Scale has value indicated in millimeters. Abbreviations used: LC, Laurer's canal; OD, oviduct; OO, ootype; P, papilla or "lip"; USR, uterine seminal receptacle; UT, uterus.

Figure 1. *Rhipidocotyle transversale* Chandler, 1935, ventral view.
Figure 2. Same, eggs.
Figure 3. *Bucephaloides bennetti* Hopkins & Sparks, 1958, ventral view.
Figure 4. Same, eggs.
Figure 5. Same, mouth showing lip, pharynx dotted in.
Figure 6. *Bucephaloides caecorum* Hopkins, 1956, ventral view.
Figure 7. Same, eggs.
Figure 8. *Opecoeloides fimbriatus* (Linton, 1934), ventro-lateral view.
Figure 9. *Pseudopecoelus manteri* (this paper), ventral view.
Figure 10A & B. *Tormopsolus filiformis* (this paper), scale drawing from camera lucida drawing of a twisted specimen, ventral view.
Figure 11. *Stephanostomum imparaspine* (Linton, 1905) Manter, 1940, ventral view.
Figure 12. Same, ventral view of oral sucker and spines.
Figure 13. *Manteria brachyderus* (Manter, 1940) Caballero, 1950, scale drawing from camera lucida drawing of a twisted specimen, ventral view.
Figure 14. Same, ventral view of oral sucker and spines.
Figure 15. Same, mehlis complex.
Figure 16. *Lecithochirium microstomum* Chandler, 1935, ventral view.
Figure 17. Same, sketch of lateral view of anterior end of body.
Figure 18. Same, sketch of terminal genitalia.
Figure 19 to 22. Same showing variation in vitelline shape.
Figure 23. *Dinurus tornatus* (Rudolphi, 1899) Looss, 1907, lateral view.
Figure 24. Same, enlarged sketch of anterior end of body showing anterior extent of cuticular denticulations and posterior extent of hermaphroditic duct.



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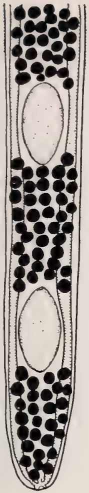

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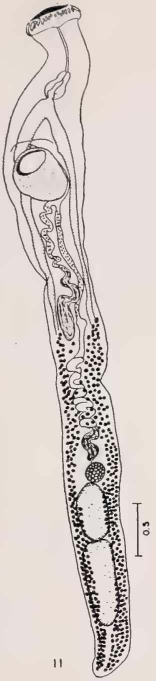

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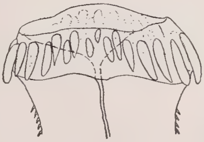

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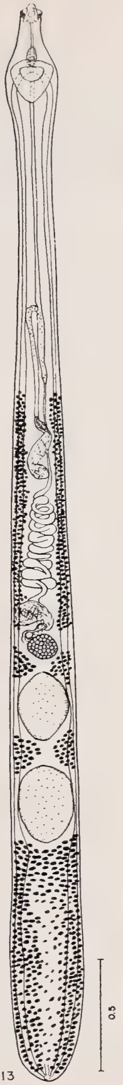

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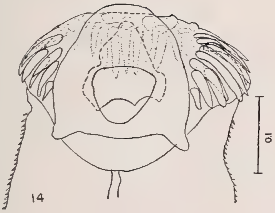

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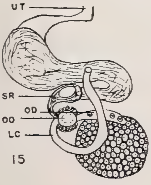

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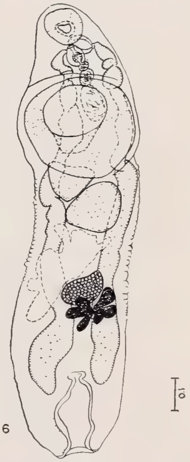

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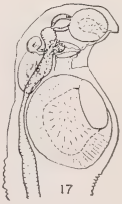

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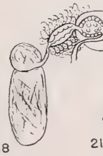

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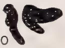

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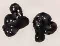

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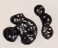

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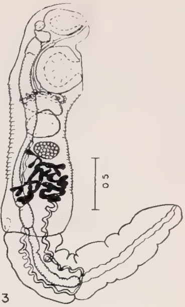

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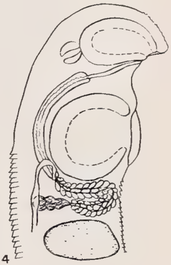

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This report of *B. caecorum* from Florida represents a new locality record.

Family Opecoelidae Ozaki, 1925

4. *Opecoeloides fimbriatus* (Linton, 1934) Sogandares & Hutton (in press)

(Fig. 18)

Host: *Bairdiella chrysurus* (Lacepede); silver-perch; family Sciaenidae
Incidence of Infection: In 1 of 9 hosts
Number: One
Location: Pyloric cecum
Locality: Tarpon Key, Boca Ciega Bay, Florida

Discussion: Sogandares & Hutton (in press) have reported what they believe to be the metacercaria of *O. fimbriatus* encysted in the cephalothoracic cavity of the shrimp, *Penaeus duorarum* Burkenroad. Since this report, we have found a single adult of *O. fimbriatus* in a pyloric cecum of *Bairdiella chrysurus*.

The specimen of *O. fimbriatus* pictured in Figure 7 has a contracted anterior and posterior body. Aside from the fact that a uroproct is formed, the specimen is believed to be conspecific with the holotype of *O. fimbriatus* (USNM Helm. Coll. No. 8266) which we have examined. The acetabular papillae in the holotype of *O. fimbriatus* are somewhat retracted.

Linton (1905) pictures a specimen of *O. fimbriatus* (Fig. 178) from Beaufort, North Carolina. Hopkins (1941) reported both *O. fimbriatus* and *O. vitellosus* in *Bairdiella chrysurus* from the same locality. Sparks (1958) examined *Bairdiella chrysurus* in Grand Isle, Louisiana, but did not report *O. fimbriatus* from that area. Precluding the chance that *O. polynemi* Von Wicklen, 1946, is not a synonym of *O. fimbriatus*, this report appears to be the northernmost record of the species in the Gulf of Mexico.

5. *Pseudopecoelus manteri* n. sp.

(Fig. 9)

Host: *Bairdiella chrysurus* (Lacepede); silver-perch; family Sciaenidae
Incidence of Infection: In 4 of 9 hosts
Number: 1, 1, 1, 1

Location: Pyloric ceca
Locality: Tarpon Key, Boca Ciega Bay, Florida
Holotype: U. S. Nat. Mus. Helm. Coll. No. 39002

Diagnosis (Based on 4 specimens): *Pseudopecoelus;* body elongate, plump, broadly rounded posteriorly, conical anterior to acetabulum, 0.94 to 1.44 long by 0.42 to 0.56 wide. Cuticle unspined. Oral sucker terminal, 0.06 to 0.08 long by 0.10 to 0.12 wide. Acetabulum in anterior ⅓ body, short pedunculate, unornamented, 0.18 to 0.20 long by 0.16 to 0.22 wide. Sucker ratio 1:0.9 to 1.1. Prepharynx from ¼ length to approximately same length as pharynx. Pharynx 0.05 to 0.07 long by 0.06 to 0.07 wide. Esophagus approximately same length of pharynx. Cecal bifurcation immediately preacetabular; ceca ending blindly ⅔ distance between posterior testis and posterior end of body. Genital pore sinistral and level with anterior border of pharynx. Testes 2, intercecal, roundish, oblique, almost in contact with each other, anterior testis equatorial, sinistral to midline of body, 0.14 to 0.18 long by 0.16 to 0.18 wide; posterior testis dextral or median, 0.14 to 0.22 long by 0.12 to 0.20 wide. Seminal vesicle from slightly posterior to acetabulum to enter a prostatic vesicle which is approximately same length of pharynx and connects with a very short cirrus which opens through genital pore. Ovary either with a single anterior notch or smooth, roundish to subtriangular in shape, to the right and level with anterior testis; 0.06 to 0.14 long by 0.10 to 0.12 wide. Seminal receptacle absent. Vitellaria medianly coalescing anterior and dorsal to acetabulum, extending posteriorly on each side of the body, overlapping ceca dorsally and ventrally to fill posttesticular space dorsally and ventrally. Uterus preovarian, extending from ovary to genital pore. Eggs collapsed, 48 to 60 microns long by 28 to 36 microns wide. Excretory pore terminal or subterminal, depending upon contraction of posterior end of body. Excretory vesicle tubular, extending from excretory pore to posterior level of ovary.

The name *manteri* is in honor of Professor Harold Winfred Manter, Department of Zoology, University of Nebraska, in recognition of his extensive contributions to the field of helminthology.

Discussion: This species is identified as *P. umbrinae* Manter & Van Cleave, 1951 and *P. gibbonsiae* Manter & Van Cleave, 1951 in Manter's (1954b: p. 6) key. Both species are from the coast of

California. *Pseudopecoelus manteri* differs from *P. umbrinae* by possessing smaller testes, an ovary which is never 3 to 4 lobed, and longer prostatic vesicle. *Pseudopecoelus manteri* differs from *P. gibbonsiae* by possessing a seminal vesicle which extends only slightly posterior to acetabulum, oblique testes, and genital pore at anterior border of pharynx, as compared with seminal vesicle extending far beyond acetabulum, almost to ovary, tandem testes and genital pore at mid-pharyngeal level. *Pseudopecoelus manteri* differs from all other species of *Pseudopecoelus* by possessing vitellaria which extend anterior to acetabulum as compared with vitellaria posterior to acetabulum.

Pseudopecoelus manteri in this collection was found associated with *Bucephaloides caecorum* Hopkins, 1956 and *Tergestia pectinata* (Linton, 1905) Manter, 1940.

Family Acanthocolpidae Lühe, 1906

6. *Tormopsolus filiformis* n. sp.

(Figs. 10A, 10B)

Host: *Rachycentron canadus* (Linn.); cobia; family Rachycentronidae
Incidence of Infection: In 1 of 1 host
Number: 5
Location: Rectum
Locality: Gulf of Mexico, 8 miles offshore from John's Pass, Madeira Beach, Florida
Holotype: U.S.N.M. Helm. Coll. No. 39003

Diagnosis (based on 5 specimens): *Tormopsolus*; body filiform, mainly cylindrical, 4.85 to 5.65 long by 0.20 to 0.36 wide at acetabulum. Cuticle spined to level of testes. Diffuse "eye-spots" present at mid-pharyngeal level. Forebody 0.90 to 1.30 long. Oral sucker terminal, 0.04 long by 0.05 to 0.06 wide. Acetabulum in anterior ¼ body, 0.09 by 0.09 to 0.10 wide. Prepharynx half length of forebody. Pharynx 0.07 to 0.08 long by 0.04 to 0.05 wide. Esophagus absent. Ceca extending from cecal bifurcation, one on each side of body to end at posterior end of body in a uroproct. Genital pore median, immediately pre-acetabular, followed by a long unspined muscular hermaphroditic duct which extends intercecally from genital pore, dorsal to acetabulum, to end approximately in anterior ⅓ body. Testes 2, intercecal, in tandem in posterior ¼ body; anterior testis 0.12 to 0.28 long by 0.16 to 0.18 wide; posterior testis 0.30 to 0.32 long by 0.16 wide. Cirrus sac mainly intercecal, dextral, extending from about equator of body to enter hermaphroditic duct; containing a heavily spined cirrus which is slightly longer than the bipartate internal seminal vesicle. Ovary intercecal, in posterior ⅓ body, 0.12 to 0.14 long by 0.12 to 0.14 wide. Vitellaria completely surrounding body ventrally and dorsally from posterior tip of cirrus sac, interrupted at level of ovary and each testis, to end at posterior end of body. Uterus extending intercecally from ovary to a heavily spined metraterm which is about same size of cirrus sac and connects with posterior portion of the hermaphroditic duct and cirrus sac junction. *Receptaculum seminis uterinum* present. Anterior extent of excretory vesicle not observed.

The name *filiformis* is from the latin *filum* (= hair)-*forma* (= form) for the hair-like appearance of the body of this species.

Discussion: Prior to our description of *T. filiformis* there were three species in the genus *Tormopsolus* Poche, 1926. These species are *T. osculatus* (Looss, 1901) Poche, 1926; *T. orientalis* Yamaguti, 1934 and *T. lintoni* Caballero, 1952. *Tormopsolus filiformis* differs from these species by possessing a hermaphroditic duct which extends far posterior to the acetabulum (almost ⅓ distance from acetabulum to the anteriormost reach of the vitellaria) as compared with at most, hermaphroditic duct extending only a short distance posterior to acetabulum. *Tormopsolus filiformis* further differs from *T. osculatus* and *T. orientalis* by possessing a much longer forebody (proportionately twice as long) and longer prepharynx; and from *T. lintoni* by possessing an ovary which is separated from the anterior testis by a band of vitellaria.

7. *Stephanostomum imparaspine* (Linton, 1905) Manter, 1940
(Figs. 11 to 12)

Host: *Rachycentron canadus* (Linn.); cobia; family Rachycentronidae

Incidence of Infection: In 1 of 1 hosts

Numbers: 5

Location: Rectum

Locality: Gulf of Mexico, 8 miles offshore from John's Pass, Madeira Beach, Florida; new locality record.

Discussion: Linton (1905) described *Distomum imparaspine* from *Rachycentron canadus* in Beaufort, North Carolina. To our knowledge, the species has not since been reported in the literature until Manter (1940) placed *D. imparaspine* in the genus *Stephanostomum.*

Our specimens possessed from 33 to 34 oral spines. *S. imparaspine* resembles *S. hispidum* but differs in the number of crown spines (33 to 34 as compared with 40 to 42), and ovary always in contact with anterior testis as compared with ovary separated from anterior testis by a band of vitelline follicles.

It has been the current practice of ichthyologists to use the name Rachycentridae for the type genus *Rachycentron.* The name should be Rachycentronidae as here used.

8. *Manteria brachyderus* (Manter, 1940) Caballero, 1950
(Figs. 13 to 15)

Host: *Oligoplites saurus* (Bloch & Schneider); family Carangidae
Incidence of Infection: In 1 of 3 hosts
Numbers: 2
Location: Rectum
Locality: Bayboro Harbor, Tampa Bay, Florida; new locality record

Discussion: Manter (1940) originally placed this species in the genus *Dihemistephanus.* Caballero (1950) erected the genus *Manteria* for this species of Manter. Yamaguti (1953) placed the species in the genus *Dihemistephanus* and considered Caballero's (1950) *Manteria,* a sub-genus. *Manteria brachyderus* cannot be included in *Dihemistephanus* because *D. lydiae,* genotype, possesses a seminal receptacle. We have in our possession, 2 specimens of *D. lydiae* collected by Professor Manter from *Mola mola* in New Zealand and the seminal receptacle is definitely present. The presence of the seminal receptacle in *D. lydiae* would probably place it in the Deropristinae Cable & Hunnienen, 1942 of the Lepocreadiidae. The structure of the oral sucker, ventrally interrupted spines and an anterior acetabulum would place Manter's (1940) *Dihemistephanus brachyderus* in a genus all its own as proposed by Caballero (1950). For the present time, we prefer to retain *Manteria* Caballero, 1950. Our specimens possessed 30 and 32 oral spines respectively. Ather Siddiqui (personal communication), Purdue University, has studied specimens of *M. brachyderus* collected by Professor Raymond Cable, of the same institution, in Puerto Rico. He states that his immature specimens possess about 35, and mature specimens 41 to 47 oral spines. Professor Manter made a paratype of *M. brachyderus* available for our study. His specimen had 50 oral spines. We also have in our possession a specimen of *M. brachyderus* collected by Miss Margarita Bravo-Hollis, Instituto Nacional de Biologia (Mexico), in the Mexican Pacific. The oral spines have been lost, but the specimen is otherwise in good condition. Based on the material available for our study, we hesitate to name a new species for the Atlantic *Manteria* only on the basis of numbers of oral spines.

Caballero (1950) considers Linton's (1940) record of *Stephanostomum* sp. from Woods Hole, Massachusetts to be the same species as *M. brachyderus*. This record is the first from the Gulf of Mexico.

Family HEMIURIDAE Lühe, 1901

9. *Lecithochirium microstomum* Chandler, 1935

(Figs. 16 to 22)

Host: *Coryphaena equisetis* ? Linn.; small dolphin; new host record; family Coryphaenidae

Incidence of Infection: In 1 of 3 hosts

Numbers: 6

Location: Stomach

Locality: Gulf of Mexico, 15 mi. west of Pass-a-Grille, Florida

Discussion: The specific identity of the host was not definitely established. The worms were dropped into cold A.F.A. fixative and the ecsoma of all specimens was retracted. Manter (1947) has pointed out that Chandler's (1935) figure of *L. microstomum* does not show a membrane surrounding the posterior end of the cirrus sac. Figure 18 is a sketch of the appearance of the terminal genitalia in our specimens. Figures 19 to 22 show observed variation of vitelline shape in our material.

Lecithochirium microstomum is known from the stomachs of many unrelated fishes in the American Atlantic and Tropical American Pacific. This report is the first from a fish of the genus *Coryphaena.*

10. *Dinurus tornatus* (Rudolphi, 1899) Looss, 1907
(Figs. 23 to 24)

Host: *Coryphaena equisetis* ? Linn.; small dolphin; family Coryphaenidae
Incidence of Infection: In 3 of 3 hosts
Numbers: Not counted
Location: Stomach
Locality: Gulf of Mexico, 15 miles west of Pass-a-Grille, Florida

Discussion: The specific identity of the host is in question. All three hosts were collected from a single school of small dolphins.

Manter (1947) reported *D. tornatus* from *Coryphaena hippurus* in Tortugas, Florida, and Linton (1905) from *Coryphaena hippurus* and *C. equisetis* in Beaufort, North Carolina. Ward (1954) reported "*D. tornatus*" from the Miami, Florida area. She followed Dawes (1947) in considering *D. longisinus* Looss, 1907, a synonym of *D. tornatus.* The species Ward (1954) pictures (Fig. 3) may be *D. longisinus* because the hermaphroditic duct extends to the middle of the acetabulum. Dawes (1947) considers *Dinurus barbatus* (Cohn, 1903) Looss, 1907, *D. breviductus* Looss, 1907, *D. longisinus* Looss, 1907, synonyms of *D. tornatus* (Rudolphi, 1899) Looss, 1907. One of us (F.S.) has *Dinurus* spp. collected from *Coryphaena hippurus* in the Gulf of Panama and in Bimini, B.W.I., and in addition has been privileged to study Professor Manter's series of *Dinurus* spp. from *Coryphaena hippurus* collected in Tortugas, Florida and the Tropical American Pacific. *Dinurus tornatus* may be easily separated from *D. longisinus* because the cuticle in the former species is denticulated to the acetabulum (Figs. 23 to 24) and the hermaphroditic duct extends almost to or beyond the posterior border of the acetabulum, as compared with cuticular denticulations extending to the oral sucker and hermaphroditic duct extending to about the middle of the acetabulum in *D. longisinus.* These differences appear to be constant in several hundred specimens which one of us (F.S.) has been able to observe. The fact that most *Dinurus* spp. may live together in a single host is not evidence enough for synonymy of the species as presented by Dawes (1947). There are numerous examples to indicate that closely related species and genera may cohabit in the same host. The finding of closely related species living together in one host would imply a strong degree of host specificity accompanying evolution. Manter (1957) shows how the accacoelid trematodes of *Mola mola* are a good example of such evolution. There is no definite contrary evidence to show that hermaphroditism is the rule in the Digenea. There is some evidence that cross fertilization occurs, and it may be more common than we at present suspect or assume. The differences of the cuticular denticulations of *Dinurus tornatus* and *D. longisinus* could possibly be a recognition character preventing interspecific mating if cross fertilization occurs in this group of trematodes. Thus in trematodes in which weak recognition characters preventing interspecific matings would exist, hybrids would be expected to result. *Pseudocreadium myohelicatum* (Bravo & Manter, 1957) seems to be just such a hybrid example (*Pseudocreadium scaphosomum* Manter, 1940 X *Pseudocreadium spinosum* Manter, 1940). Such a hybridization may perhaps occur when two trematode species normally occur in separate host species and sometimes are accidentally in one host species together. Recognition characters preventing interspecific matings in these instances would possibly be weaker than when both species normally occur together in one host species as is the case in the *Dinurus* spp. in *Coryphaena* spp., in the *monorchiids* from *Haemulon* spp., and in the accacoelids from *Mola mola.* Price (1953) believed hybridization between *Faciola hepatica* and *F. gigantica* existed in cattle in the Southeastern United States. If trematode hybrids exist these would probably be confused with intergradation between two closely related species by most observers. Such may be the case in some *Dinurus* spp. confused as synonyms by some investigators.

Summary

1. Two new trematodes are named and described. These species are: *Pseudopecoelus manteri* (family Opecoelidae) from *Bairdiella chrysurus* in Boca Ciega Bay, Florida, and *Tormopsolus filiformis* (family Acanthocolpidae) from *Rachycentron canadus* in the Gulf of Mexico.
2. New host records are as follows: *Rhipidocotyle transversale* Chandler, 1935 (family Bucephalidae) in *Strongylura timucu*?; *Bucephaloides bennetti* Hopkins & Sparks, 1958 (family Bucephalidae) in *Paralichthys albiguttus;* and *Lecithochirium microstomum* Chandler, 1935 in *Coryphaena equisetis*?.

3. New locality records are: From Tampa and/or Boca Ciega Bays, *Rhipidocotyle transversale* Chandler 1935; *Bucephaloides bennetti* Hopkins & Sparks, 1958; and *Bucephaloides caecorum* Hopkins, 1956 (family Bucephalidae) *Manteria brachyderus* (Manter, 1940) Caballero, 1950 (family Acanthocolpidae); from the Gulf of Mexico, *Stephanostomum imparaspine* (Linton, 1905) Manter, 1940 (family Acanthocolpidae).
4. Information pertaining to the exact location and numbers of each trematode species within its respective host(s) is given when possible.

References Cited

CABALLERO yC. , E.
1950. Un nuevo genero de tremiatodo de peces marinos perteneciente a la familia Acanthocolpidae, 1909. Ann. Inst. Biol. (Mexico), 21(1): 95-102.

CHANDLER, A. C.
1935. Parasites of fishes in Galveston Bay. Proc. U. S. Nat. Mus., 83: 123-157.

DAWES, B.
1947. The trematoda of British Fishes. The Ray Society, 364 pp.

KILBY, J. D.
1955. The fishes of two gulf coastal marsh areas of Florida. Tulane Stud. Zool., 2(8): 175-247.

LONGLEY, W. H., and S. F. HILDEBRAND
1941. Systematic catalogue of fishes of Tortugas, Florida. Carnegie Inst. Wash. (Pub. 535), Papers Tortugas Lab., 34: 1-331, 34 pls.

HOPKINS, S. H.
1941. Excretory systems of *Helicometra* and *Cymbephallus* (Trematoda), with remarks on their relationships. Trans. Am. Micr. Soc., 50(1): 41-44.

1954. The American species of trematode confused with *Bucephalus* (*Bucephalopsis*)*haeimeanus*. Parasitol., 44(3&4): 353-370.

1956. Two new trematodes from Louisiana, and the excretory system of Bucephalidae. Trans. Am. Micr. Soc., 75(1): 129-135.

HOPKINS, S. H., and A. K. SPARKS
1958. A new species of *Bucephaloides* (Trematoda; Bucephalidae) from a marine fish of Grand Isle, Louisiana. J. Parasitol., 44(4): 409-411.

LINTON, E.
1905. Parasites of fishes of Beaufort, North Carolina. Bull. Bur. Fish. 24: 321-428, 34 pls.

1940. Trematodes from fishes mainly from the Woods Hole region Massachusetts. Proc. U. S. Nat. Mus., 88: 11-72, 26 pls.

MANTER, H. W.

1940. Digenetic trematodes of fishes from the Galapagos Islands and neighboring Pacific. Allan Hancock Pac. Exp. 2(14): 329-497.

1947. Digenetic trematodes of marine fishes of Tortugas, Florida. Amer. Mid. Nat., 38(2): 257-416.

1954a. Trematoda of the Gulf of Mexico, in Gulf of Mexico its origin, waters, and marine life. Fish. Bull. U. S. Fish & Wildlife Service, 89: 335-350.

1954b. Some digenetic trematodes from fishes of New Zealand. Trans. Roy. Soc. N. Z., 82(2): 475-568.

1957. Host specificity and other host relationships among the digenetic trematodes of marine fishes. First Symposium on host specificity among parasites of vertebrates (Neuchatel): 185-196.

MANTER, H. W., and H. VAN CLEAVE

1951. Some digenetic trematodes, including eight new species, from marine fishes of La Jolla, Calif., Proc. U. S. Nat. Mus., 101: 315-340, 2 pls.

PRICE, E.

1953. The fluke situation in American ruminants. J. Parasitol., 39: 119-134.

SOGANDARES-BERNAL, F., and R. F. HUTTON

(*In Press*) Studies on helminth parasites from the coast of Florida. III. Digenetic trematodes of marine fishes from Tampa and Boca Ciega Bays. 2. J. Parasitol.

SPARKS, A. K.

1958. Some digenetic trematodes of fishes of Grand Isle, Louisiana. Proc. Louisiana Acad. Sci., 20: 71-82.

WARD, H.

1954. Parasites of marine fishes of the Miami region. Bull. Mar. Sci. Gulf and Carib., 4(3): 244-261.

YAMAGUTI, S.

1953. Systema Helminthum. Part I. Digentic trematodes of fishes. Maruzen Co. Ltd., Nihobashi, Tokyo, Jayan.

NOTES ON THE EGGS AND YOUNG OF *GOPHERUS POLYPHEMUS* (DAUDIN)

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Reports on clutch and egg size of *Gopherus polyphemus* (Daudin) (Pope, 1949: Carr, 1952) and a description of a six-month-old individual (Allen and Neill, 1953) constitutes what is known of the young of the southeastern gopher turtle. Observations on two clutches of eggs and young from Alachua County, Florida, have provided additional data on these aspects of the biology of the gopher turtle.

The conspicuous mound of sand at the entrance of the burrow of the gopher turtle has been reported as a possible site for the deposition of eggs (Carr, 1952). Fifteen such mounds were excavated and resulted in the discovery of two clutches of eggs on August 20 and 21, 1958. Although the burrows examined were distributed over approximately 20 acres, the two mounds containing eggs were but 50 feet apart. The eggs in each nest had been laid in one plane, about six inches beneath the surface. The sand above the eggs was exposed to the full rays of the sun.

The clutches were composed of six and seven eggs, respectively. The eggs of the smaller clutch were considerably smaller than those of the larger, and all were somewhat more elliptical than reported by Pope (1949) and Carr (1952), but fell within the general size range recorded for the species. The eggs of each clutch were closely uniform in size and weight, but differences between the two clutches were marked (Fig. 1).

The eggs were brought into the laboratory and incubated in gallon jars lined with moistened paper towels. Hatching began fifteen days later, and the process was observed in some detail for seven young. The sequence of events in each instance was closely similar. The initial cracks in the shell appeared to be made by butting or forcing the snout against the inner surface of the egg. The opening thus made was further enlarged by biting the edge of the opening and withdrawing the head, thereby breaking additional portions of the shell. As the opening became larger, the forelimbs were brought increasingly into play, until eventually the right forelimb could be extended out of the shell (Fig. 2). In all cases, the right forelimb was protruded first. Eventually the left forelimb was exposed in the same manner. By this time the shell had been broken virtually in two, so that further struggling and movement resulted in the hatchling tumbling out of the shell.

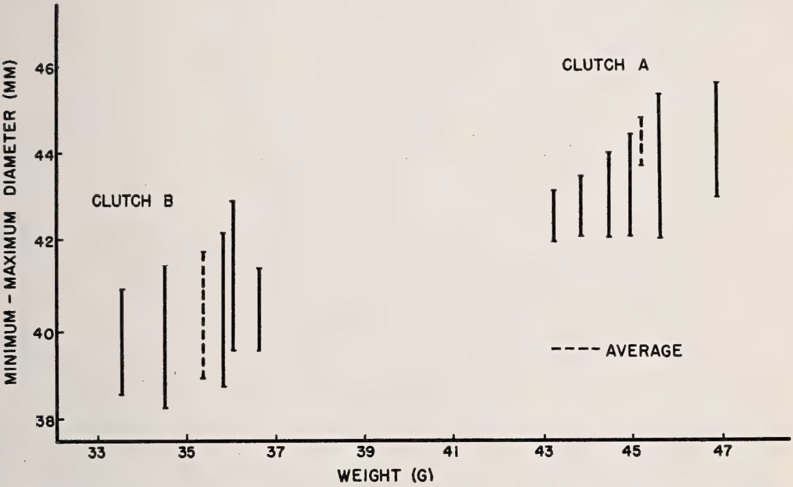

Figure 1. Variation in the size and weight of the eggs of two clutches of *Gopherus polyphemus.*

Hatching required an average of 24 hours, at the end of which time the yolk sac was still large, averaging 10 x 10 x 5 mm. A deep transverse flexure, running across the plastron, between the hyoplastal and hypoplastal elements, allowed the embryonic turtle to fit within the shell. Upon hatching this flexure began to straighten, allowing the remaining yolk to be withdrawn into the enlarging body cavity. Considering the size of the yolk sac at hatching, this withdrawal was rapid, being completed within an additional 18 to 24 hours. This large amount of yolk thus taken into the body cavity would probably explain the seeming indifference of the hatchling to food. Within a day or two they would nibble on green grasses and cantalope, but ate very little. Within 24 hours the yolk sac had disappeared, and the anterior and posterior lobes of the plastron had straightened sufficiently to allow the young to walk. Considering the condition of the young at hatching and the changes which must take place before locomotion

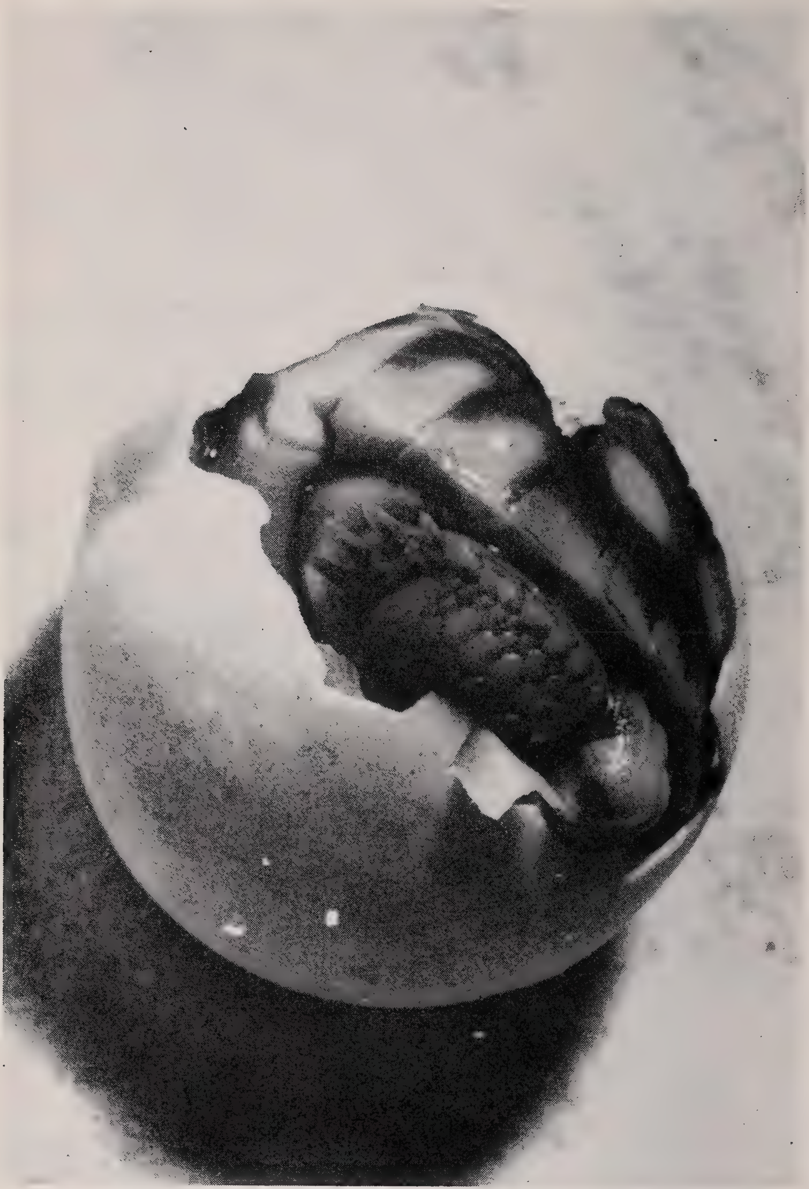

Figure 2. Young of *Gopherus polyphemus* emerging from the egg: about 12 hours after pipping.

is possible, it seems reasonable to assume that under natural conditions they must spend at least a day in the nest before emerging.

The hatchlings from the larger clutch all emerged from the eggs within two days (September 4 to 5), those from the smaller clutch within four (September 22 to 25). One egg failed to hatch within a week following the emergence of the last previous hatchling of the same clutch. This egg was opened, and the embryo was found dead. It was deformed, with the neck and head extended and rigid, lying along, but not fused to, the right brachium. The gulars were massive, and the hindlimbs small and projecting posteriorly. The plastron had not developed the flexure, and the embryo had folded dorsally, presumably causing the death of the individual.

Immediately upon hatching the young averaged 42.9 mm. in length and 43.4 mm. in width. Within six hours these proportions had changed (43.4 mm. in length x 42.1 mm. in width) as a result of the straightening of the body axis. Because of this early "unrolling", comparative measurements were not made until the individuals were at least three days old. A similar post-hatching developmental pattern has been described for *Gopherus agassizii* by Grant (1936). At the end of three days the flexure had almost disappeared and a more constant width/length ratio had been established (Table 1). This is about the same as the ratio (0.86) reported for a 56 mm. individual by Goin and Goff (1941). Intra and inter clutch size and weight relationships of the young paralleled those of the eggs. However, there was no overlap in the size and weight of the hatchlings of the different clutches (Table 1). In general, the larger eggs produced the larger hatchlings.

The coloration of the seven hatchlings examined varied considerably. Not only was there variation between the hatchlings at a given age, but ontogenetic trends were also evident. In general, the hatchlings displayed light to dark yellow centers on the dorsal laminae, as well as on the head and forelimbs; a darker, grayish-yellow on the hindlimbs; a lighter, pinkish-yellow on the plastron; and the margins of the dorsal laminae and marginal series ranged from a deep grayish-brown to brownish-gray. The colors are given more precisely in Table 2. Additional variation existed in the amount of yellow present in the centers of the dorsal laminae (Fig. 3). The texture of the shell of the hatchlings was very granular. The hatchlings agreed generally in coloration with the description

TABLE 1.—LENGTH OF FOUR YOUNG *GOPHERUS POLYPHEMUS* DURING FIRST MONTH, AND COMPARISON WITH THREE SIBLINGS OF A DIFFERENT CLUTCH AT ONE WEEK OF AGE. WIDTH/LENGTH RATIOS ARE GIVEN IN PARENTHESES. (LENGTH IN MM.)

	Clutch A					Clutch B			
Age	1	2	3	4	Avr. (l/w)	1	2	3	Avr. (l/w)
3 days	49.0	47.7	47.4	48.4	*48.1 (.885)*				
1 week	49.7	49.8	48.4	48.1	*49.0 (.867)*	45.0	46.2	45.9	*45.7 (.864)*
2 weeks	50.3	50.4	48.9	48.1	*49.4 (.850)*				
1 month	50.6	51.2	49.0	48.5	*49.7 (.855)*				

TABLE 2. COLOR VARIATION IN SEVEN HATCHLING *GOPHERUS POLYPHEMUS* FROM ALACHUA COUNTY, FLORIDA. (COLOR DESIGNATIONS FROM MAERZ AND PAUL, 1930).

	Clutch A				Clutch B		
Structure	1	2	2	4	1	2	3
Head	10J4	12E4	12J4	11H5	10I4	11L5	11L3
Forelimb	10K7	12L7	11L6	11L7	11K4	10L8	11H5
Hindlimb	11J8	13K7	11J6	11F7	10I6	10L6	9K4
Marginals*	10J5	10I5	9I3	9L6	10J8	9K4	9K3
Vertebrals* and Costals	9L6	10K4	9J2	9J7	9K4	9H5	9J3
Plastron	9K5 9J4	9J4 9J6	9J3 9K5	9J2 9I7	9J3 9J5	9I3 10J6	9J5 10H2

* The gray-brown color of the margin of the dorsal laminae is not listed.

of a six-month-old individual by Allen and Neill (1953), but were lighter and brighter.

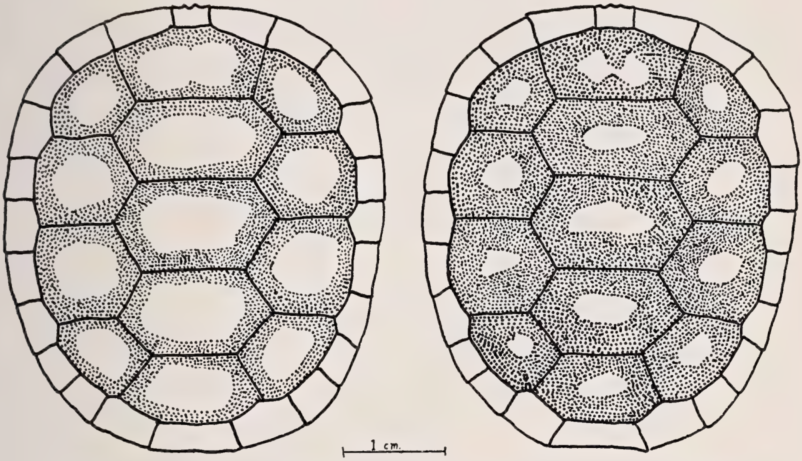

Figure 3. Extremes of variation in the color pattern of seven hatchlings of *Gopherus polyphemus.*

During the excavation of the clutches, several eggs were injured. The contained embryos were preserved. One specimen, estimated at 31 days prehatching (on the basis of the date the remaining eggs in the clutch hatched) had a carapace length of 34.1 mm. and width of 27.3 mm. The plastral flexure had not yet appeared. Another embryo, 15 days prehatching, was 41.9 mm. x 36.0 mm. The plastral flexure in this specimen was pronounced. Neither of these specimens showed the yellow coloration of the hatchlings, but rather were varying shades of gray and white. Both showed typical adult scalation. A third embryo, removed from the egg 15 days before the others in the clutch hatched, showed the faintest tinge of yellow on the dorsal laminae, head, and forelimbs. It thus appears that the coloration of the hatchlings develops within the last two weeks of embryonic development.

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LITERATURE CITED

ALLEN, ROSS, and W. T. NEILL
1953. Juveniles of the tortoise, *Gopherus polyphemus*. Copeia No. 2: 138.

CARR, ARCHIE F.
1952. Handbook of turtles. Comstock Press, Ithaca. 542 pp.

GOIN, C. J., and C. C. GOFF
1941. Notes on growth rate of *Gopherus polyphemus*. Herpetologica, 2: 66-68.

GRANT, CHAPMAN
1936. Southwestern desert tortoise, *Gopherus agassizii*. Zoologica, 21: 225-9.

POPE, C. H.
1949. Turtles of the United States and Canada. Knopf, N. Y. 343 pp.

MAERZ, A., and M. R. PAUL
1930. A dictionary of color. McGraw-Hill, New York. 207 pp.

Quart. Journ. Fla. Acad. Sci. (1958), 21(3), 1959.

EFFECT OF STAGE OF GESTATION, DIETARY ENERGY AND PROGESTERONE ON THE SUCCINOXIDASE OF SWINE UTERI[1, 2]

R. L. Shirley, C. E. Haines, A. C. Warnick, H. D. Wallace, and G. K. Davis
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Improvement in reproduction can be expected as a better understanding is obtained of how dietary and physiological factors affect enzymatic chemistry of uterine tissues. Telfer (1953) and Longwell and Reif (1955) reported that estogens increased succinoxidase activity in the rat uterus. Lutwak-Mann and Adams (1957) reported that carbonic anhydrase activity was increased in rabbit endometrium by administration of progesterone.

The present study was made to determine the effect of different stages of gestation on succinoxidase activity of the endometrium and myometrium of the uteri of swine fed at 2 energy levels with and without progesterone.

Experimental

Duroc gilts weighing approximately 120 lb were divided into 2 dietary groups and fed the following rations:

Ingredients	Ration A (Full Fed Group lb)	Ration B (Limited Fed Group lb)
Ground corn	50	16
Ground oats	23	0
Alfalfa leaf meal	10	20
Soybean meal	10	44
Meat and bone scraps	5	17
Limestone	1	1
Steamed bonemeal	1	1
Trace mineralized salt	0.53	1.06
Lederle Aurofac-2A	0.3	0.6
	100.83	100.66

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[1] Florida Agricultural Experiment Station Journal Series, No. 510.
[2] The writers wish to thank J. F. Easley for technical assistance.

Ration A was fed *ad libitum* and these gilts were designated as the full energy dietary group. Those fed ration B were limited to half the quantity of feed intake of those fed ration A and thereby received approximately the same amount of protein, minerals, vitamins and antibotic but half the dietary energy. Twenty-seven gilts were bred at the second estrous period which averaged about 100 days after they were put on the rations. Six to 7 gilts fed at each energy level were sacrificed at 3 and 25 days of gestation.

Another group of 28 gilts of similar age, weight and breed were fed the full energy ration until the second estrous period. The gilts were bred at this time, and one half were placed on the limited energy ration. One half of the gilts of each dietary energy group were then injected intramuscularly in the neck with 25 mg of progesterone in corn oil every other day from the 3rd to 25th day of gestation. After 40 days of gestation 6 to 8 gilts fed at each energy level with and without progesterone were sacrificed.

Uterine samples were taken at time of sacrifice, frozen solid immediately and analyzed for succinoxidase within a few days. The endometrium and myometrium were separated before the succinoxidase activity was determined by the manometric method of Schneider and Potter (1943) at 38° C. Activity was calculated as μl (microliters) of oxygen uptake/gram wet weight/hour. Statistical analysis of the data was made according to Snedecor (1946).

Results and Discussion

In Fig. 1 data are graphed that were obtained for succinoxidase activity of the myometrium and endometrium of the uteri of the gilts at 3, 25 and 40 days of gestation, when fed 2 levels of energy. The gilts, sacrificed at 40 days of gestation, had been divided into 2 groups, one with and one without progesterone administration during early pregnancy. Each value graphed is the mean of the values obtained from 6 to 8 gilts. At 3 and 25 days of gestation the endometrium had more ($P<0.01$) activity than the myometrium. There was no significant difference between the myometrium and endometrium at 40 days of gestation. The succinoxidase activity decreased ($P<0.01$) as the stage of gestation increased in both tissues.

Progesterone dosage had no effect on succinoxidase activity in the uterus. No study has been made of the swine uterus in regard to concentration of progesterone actually present at specific stages of gestation. However, Kimoura and Cornwell (1938) reported on progesterone in the corpus luteum and if the uterus follows the pattern of this tissue it would be naturally high in progesterone during the present experimental period. This may be the reason why the administered progesterone had no effect on the activity of the succinoxidase.

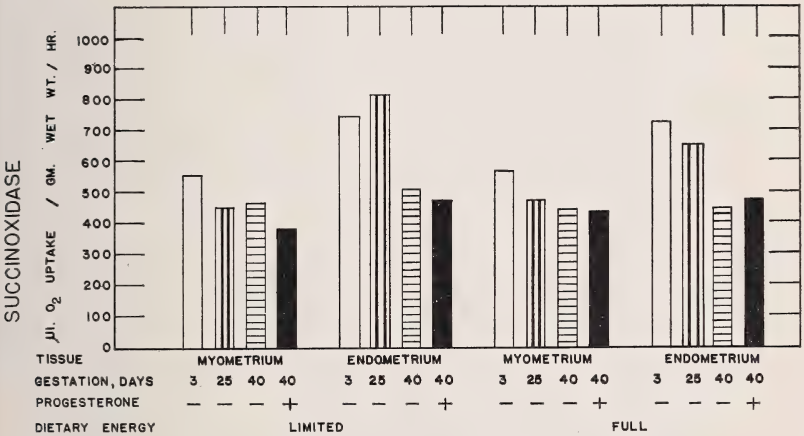

Figure 1. Succinoxidase activity of myometrium and endometrium of uteri of gilts at 3, 25 and 40 days of gestation, when fed 2 levels of energy, with and without progesterone in those sacrificed at 40 day stage of gestation.

Dietary energy level was without effect on succinoxidase activity of uterine tissues. This indicates a marked difference between uterus and heart, as Shirley et al. (1956) observed that similar gilts fed a full dietary energy ration had more ($P<0.01$) succinoxidase in the heart than those fed the limited energy ration.

Summary

The endometrium had more ($P<0.01$) succinoxidase activity at 3 and 25 days of gestation than the myometrium of the uteri of swine. As the stage of gestation increased from 3 to 25 to 40 days, a decrease ($P<0.01$) occurred in succinoxidase activity in both the endometrium and myometrium. Limiting the dietary energy to about one-half of the normal intake did not affect the succinoxidase activity. Progesterone given to gilts which were

sacrificed at 40 days of gestation had no effect on the activity of the succinoxidase.

LITERATURE CITED

KIMOURA, A., and W. S. CORNWELL
1938. The progestin content of the corpus luteum of the sow (Sus Scrofa) during successive stages of the estrous cycle and pregnancy. *Am. J. Physiology* 123: 471-476.

LONGWELL, B. B., and A. E. REIF
1955. The relation between uterine growth and accretion of the succinoxidase system. *Arch. Biochem. Biophys.* 58: 92-99.

LUTWAK-MANN, CECILIA, and C. E. ADAMS
1957. Carbonic anhydrase in the female reproductive tract. II Endometrial carbonic anhydrase as indicator of luteoid potency: correlation with progestational proliferation. *J. Endocrinology* 15: 43-55.

SCHNEIDER, W. C., and V. R. POTTER
1943. The assay of animal tissues for respiratory enzymes. II Succinic dehydrogenase and cytochrome oxidase. *J. Biol. Chem.* 149: 217-227.

SHIRLEY, R. L., J. F. EASLEY, C. E. HAINES, A. C. WARNICK,

H. D. WALLACE, and G. K. DAVIS
1956. Influence of dietary energy level on succinoxidase and lactic dehydrogenase of the heart of pregnant swine. *J. Agr. and Food Chem.* 4: 67-80.

SNEDECOR, G. W.
1946. Statistical Methods. Iowa State College Press, Ames, Iowa.

TELFER, MARY A.
1953. Influence of estradiol on nucleic acids, respiratory enzymes and the distribution of nitrogen in the rat uterus. *Arch. Biochem. Biophys.* 44: 111-119.

Quart. Journ. Fla. Acad. Sci. (1958), 21(3), 1959.

ON THE STATUS OF THE ATLANTIC LEATHERBACK TURTLE, *DERMOCHELYS CORIACEA CORIACEA*, AS A VISITANT TO FLORIDA NESTING BEACHES, WITH NATURAL HISTORY NOTES [1]

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United States Fish and Wildlife Service

Carr (1952: 451) reported the first reliable record of the nesting of the Atlantic leatherback turtle, *Dermochelys coriacea coriacea* (Linnaeus), on North American mainland beaches during the past 100 years. Since that record, a second (Caldwell, Carr, and Hellier, 1956: 279) and a third (Allen and Neill, 1957: 144) have been published. In noting their second nesting record, Caldwell, Carr, and Hellier (1956: 283) remarked that each year a few nesting leatherbacks were reported to conservation agents in South Florida. These reports were of interest because biologists have always believed that the Atlantic leatherback is a rare and irregular visitor to North American beaches, if indeed it nests here at all.

New records, made available through the alert cooperation of Robert S. Pfister, James R. Pearce, and Rolland C. Byrd, agents for the Florida State Board of Conservation, now show that this turtle, while nesting rarely in Florida in comparison with the Atlantic loggerhead turtle, *Caretta caretta caretta* (Linnaeus), actually emerges regularly to nest on the beaches of the south Atlantic coast of Florida. There are 11 such records for 1957. A summary of these and the earlier records is presented in Table 1.

In addition to the nesting records, a few related natural history notes were made available.

Apparently the only instance in which the number of eggs deposited by a leatherback nesting in Florida was known is that cited by Carr (1952: 451) in which the turtle nesting at Flagler Beach (Table 1) was reported to have laid 80 eggs. Agent Pearce reported that the turtle shown in Table 1 as laying on May 30 had

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[1] Field work supported in part by National Science Foundation Grant G-1684 (University of Florida—Principal Investigator, Archie Carr).

[2] Fishery Research Biologist, South Atlantic Fishery Investigations, Brunswick, Georgia (At the time of this study, Research Assistant, University of Florida, for the above grant).

TABLE 1. SUMMARY OF RECENTLY OBSERVED NESTING ACTIVITY OF THE ATLANTIC LEATHERBACK TURTLE, *DERMOCHELYS C. CORIACEA*, IN FLORIDA

Date	Locality	Nature of Observation	Authority
June 6, 1947	Flagler Beach, Flagler Co.	Nesting turtle	Carr, 1952
Summer, ca. 1954	Ft. Pierce, St. Lucie Co.	Nesting turtle	Pfister, this paper
ca. July 15, 1955	Hutchinson's Island, Martin Co.	Track	Caldwell, Carr, and Hellier, 1956
July, 1955	Miami Beach, Dade Co.	Hatchlings on beach	Allen and Neill, 1957
ca. July 26, 1956	Hutchinson's Island, Martin Co.	Nesting turtle	Pfister, this paper
ca. April 15, 1957	Ft. Pierce, St. Lucie Co.	Track	Pfister, this paper
ca. April 15, 1957	Ft. Pierce, St. Lucie Co.	Track	Pfister, this paper
April 30, 1957	St. Lucie Co.	Track	Pfister, this paper
May 6 or 7, 1957	St. Lucie Co.	Nesting turtle	Pfister, this paper
May 17, 1957	Hutchinson's Island, Martin Co. (6½ mi. S. of Ft. Pierce Inlet)	Nesting turtle (Carcass)	Caldwell and Hellier, this paper
May 22, 1957	Hutchinson's Island, Martin Co. (4 mi. S. of Ft. Pierce Inlet)	Nesting turtle (est. 800 lbs.)	Pfister, this paper
May 27, 1957	Jupiter Island, Martin Co.	Track	Caldwell and Hellier, this paper
May 30, 1957	Jupiter Island, Martin Co.	Nesting turtle	Pearce, this paper
June 8, 1957	Indian River Co.	Track	Pfister, this paper
June 11, 1957	Juno Beach, Palm Beach Co.	Nesting turtle	Pearce, this paper
July 10, 1957	Juno Beach, Palm Beach Co.	Nesting turtle	Pearce, this paper

deposited 127 eggs in a three-foot-deep nest. He said the carapace of this individual measured 6 feet two inches in length, and that she was 7 feet 8 inches in overall length, including head. The turtle was found turned on her back (presumably by poachers) at 2 A.M., and so must not have crawled much later than midnight, since her nest had been completed. One hundred of the eggs from this nest were transferred to the Martin-county-operated House of Refuge Historical Museum on Hutchinson's Island opposite Jensen Beach and reburied there. On the morning of August 4, 66 days later, 20 turtles hatched from the nest, and on the next day 5 more were found alive when the site was dug out. The remaining 75 eggs had spoiled. This low percentage of hatch was probably due to the handling of the eggs and perhaps to unnatural conditions of reburial. Despite this, the information gained from the operation is of particular significance since it gives for the first time an indication of the time required for eggs of the Atlantic leatherback to hatch. Of the turtles that hatched, six were retained by the House of Refuge, three were given to the Bay Wood Smoked Fishery at Ft. Pierce, and 16 were presented to the Miami Seaquarium. Pfister reports that all of those kept at the House of Refuge died very quickly, and that the ones given to the Bay Wood Smoked Fishery fed well on kingfish, *Scomberomorus cavalla* (Cuvier), roe, and algae, until they escaped their crawl about the 25th of August, some 21 days after hatching. Of those sent to the Miami Seaquarium, Craig Phillips, Curator, wrote as follows:

> " . . . baby *Dermocheles* lived for some time, the final one dying while I was on vacation from Oct. 1 to Oct. 15, 1957. Several days after their arrival on August 9, all were feeding voluntarily on ground clam and squid. On Aug. 10 I force-fed them their first meal of clam, which they soon learned to take without hesitation. After a couple of weeks they were eating chopped fish as well, and despite their growth, they continued to die one after another.
>
> "I kept them in four ten-gallon glass tanks with two baby loggerheads in each tank with the trunkbacks [leatherbacks] in hopes that the readily-feeding loggerheads would create a psychological atmosphere favorable to the trunkbacks. Whether this did or not I cannot say, but at least they all fed fairly well within a short time.

> "Their manner of feeding was rather odd. Compared with the loggerheads, their movements were stiff and mechanical. They seemed to have trouble submerging to the bottom of the tank, so at feeding time (once a day) I lowered the water to about two inches so that they could reach the food without having to submerge. Feeding was accomplished by rapid opening and closings of the jaws accompanied by sidewise jerkings of the head. They seldom appeared to approach the food deliberately, but it appeared as rather a hit-or-miss proposition with them. The jaws were capable of opening to a remarkable extent for a turtle.
>
> "They kept a constant beating with their flippers, never ceasing to bump the glass with their snouts except while feeding or during rare periods of rest. Several developed sore snouts, but I cleared this up with penicillin ointment in time.
>
> "When slightly over a week old, they appeared to begin to lose the granular scales which covered the body, head, and flippers. [see Carr, 1952: 447; Caldwell, Carr, and Hellier, 1956: 280.] These scales gradually rubbed off in patches, and at the time I at first thought that they were developing some kind of fungus skin disease. As the scales rubbed off, the underlying skin bore a faint imprint of the scales and was a lighter, grayer, color than before the moult. Meanwhile, the color pattern became more intensified, the whitish stripes [Caldwell, Carr, and Hellier, 1956: 280] showing even whiter as they grew."

Agent Pearce, who reported the nesting record for June 11 (Table 1), said this turtle laid 129 eggs, about 20 of which were of irregular size. The occurrence of off-sized eggs in Atlantic leatherbacks was reported by Gosse (1851: 306—record repeated by Carr, 1952: 452) and illustrated by Caldwell, Carr, and Hellier (1956: 282). The proportions of "normal-sized" to "abnormal-sized" eggs from this nest are almost identical with those reported for a clutch of eggs for this race of turtle in Trinidad (Caldwell, Carr, and Hellier, 1956: 282) and for the Pacific leatherback, *Dermochelys coriacea schlegelii* (Garman)—see Carr (1952: 460).

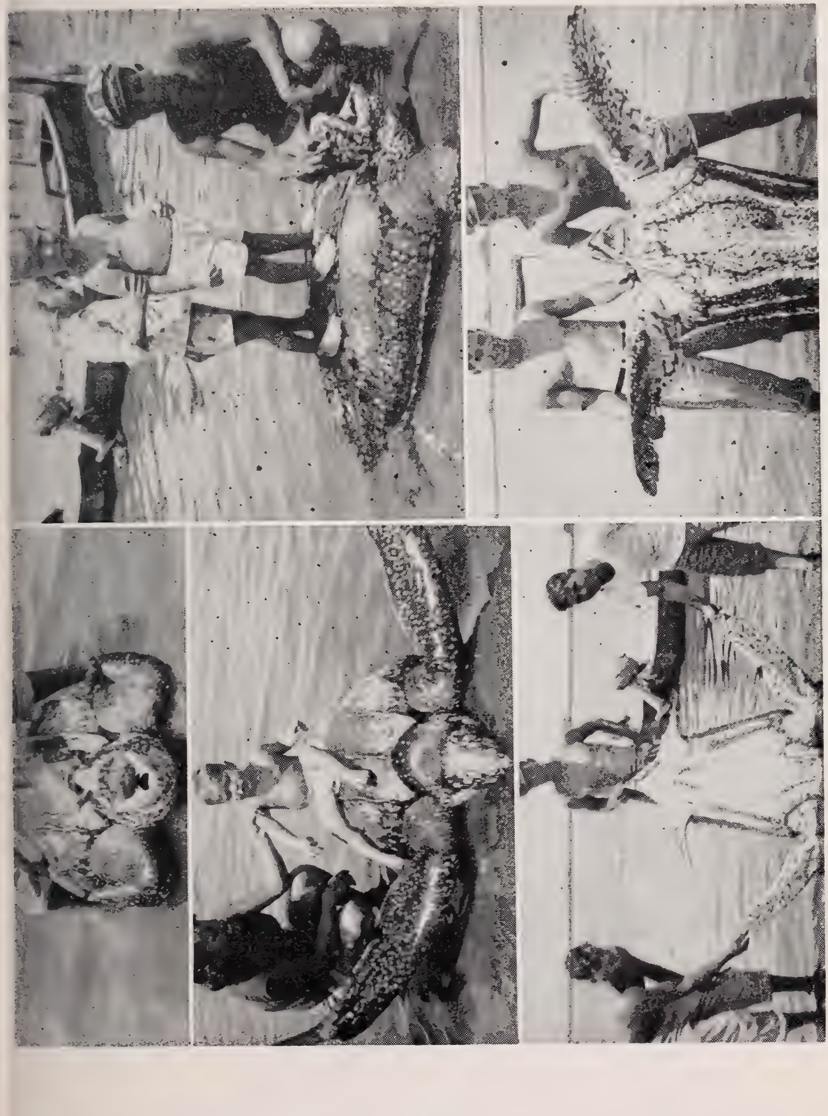

Figure 1. *Dermochelys coriacea coriacea* (Linnaeus), young, approximately three to four feet in carapace length, shot in the Indian River, Indian River County, Florida, in the summer of 1954.

Pearce's turtle, the carapace of which was 5 feet 3 inches long and three feet one inch wide, nested early in the evening—about 7 P.M.

The turtle nesting at Juno Beach on July 10 (Table 1) had a carapace length of 6 feet 7 inches and width of 3 feet one inch. Laying early in the evening (about 8 P.M.), it deposited 144 eggs. The eggs from this and the June 11th nesting were removed to the House of Refuge, but all failed to hatch.

Carr (1952: 448) notes that the Atlantic leatherback is frequently reported in Chesapeake and other inshore bays of the northern coast of North America, despite the usual association of the species with an offshore habitat. He suggested that this shoreward movement may in part be influenced by the increasing chill of the water in these northward extralimital parts of the turtle's range. It is therefore of interest to note that in the summer of 1954 a leatherback was shot in the Indian River (a long bay or lagoon protected by an outer string of barrier islands), Indian River County, on the lower Atlantic coast in Florida. In this case, being summer in the sub-tropics, when the water both inshore and offshore would be quite warm, the seeking of warm water temperatures was apparently not an influencing factor for the presence of the turtle inshore. Although no measurements were taken, snapshots furnished Pfister (Figure 1) show that the turtle was small—perhaps no more than four feet in carapace length, and probably nearer three. The The ventral (plastral) coloration of this individual is very similar to that of the hatchling illustrated by Caldwell, Carr, and Hellier (1956: 280), except that the ventral surfaces of the flippers are considerably lighter in the older specimen. The carapace and dorsal surfaces of the flippers, however, are randomly marked with light spots, rather than having the light coloration following only the carapace ridges and trailing edges of the flippers as in the hatchling noted above. Apparently the spots are gradually lost with increase in age and size (Carr, 1952: 447). These appear to be the first published photographs showing the coloration of an Atlantic leatherback of this size.

It is a pleasure to acknowledge the excellent cooperation afforded the sea turtle studies by the Florida State Board of Conservation, and especially by its agents Pfister, Pearce, and Byrd. Craig Phillips, Curator at the Miami Seaquarium, was most generous in allowing me to include his comments on the hatchlings sent him. I also wish to thank Archie Carr, of the University of Florida, and William W. Anderson, Frederick H. Berry, and Jack W. Gehringer, of the United States Fish and Wildlife Service at Brunswick, Georgia, for their comments regarding the manuscript. Thomas R. Hellier, Jr., now of the University of Texas, spent many hours "turtle watching" with me, and without his help some of these records would not have ben reported.

LITERATURE CITED

ALLEN, E. ROSS, and WILFRED T. NEILL
1957. Another record of the Atlantic Leatherback, *Dermochelys c. coriacea*, nesting on the Florida coast. *Copeia*, 1957 (2): 143-144.

CALDWELL, DAVID K., ARCHIE CARR, and THOMAS R. HELLIER, JR.
1956. A nest of the Atlantic Leatherback turtle, *Dercochelys coriacea coriacea* (Linnaeus), on the Atlantic coast of Florida, with a summary of American nesting records. *Quart. Journ. Fla. Acad. Sci.*, 18 (4): 279-284.

CARR, ARCHIE
1952. *Handbook of Turtles.* Comstock Publishing Associates, a division of Cornell University Press, Ithaca, New York, pp. xv + 542.

GOSSE, P. H.
1851. *A Naturalist's Sojourn in Jamaica.* Longman, London, pp. xxiv + 508.

Quart. Journ. Fla. Acad. Sci. (1958), 21(3), 1959.

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Vol. 21 **December, 1958** **No. 4**

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Contents

Alexander—High Hammock Vegetation of the Southern Florida Mainland 293
Alexander—Ecology of the Pompano Beach Hammock 299
Morton—Marriage Patterns Among Evening College Students 305
Shirley, McKigney, Wallace, Hentges, and Davis—Effect of Chlortetracycline on the Succinoxidase and Lactic Dehydrogenase of the Heart of Swine and Cattle 312
King—Observations on the Ecology of a New Population of the Mediterranean Gecko, Hemidactylus Turcicus, in Florida 317
Grigg and Allen—Awareness of Florida College Students of the State Nuclear Program 319
Hutton and Sogandares-Bernal—Further Notes on Trematoda Encysted in Florida Mullets 329
Waitz and Lackey—Morphological and Biochemical Studies on the Organism *Sphaerotilus natans* 335
Collins—Studies on Water Relations in Florida Termites I. Survival Time and Rate of Water Loss During Drying 341
Phillips—Two New Species of *Lyngbya* C.Ag. 353

Vol. 21 DECEMBER, 1958 No. 4

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THE QUARTERLY JOURNAL OF THE
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HIGH HAMMOCK VEGETATION OF THE SOUTHERN FLORIDA MAINLAND

Taylor R. Alexander
University of Miami

Introduction

Along Biscayne Bay from the Miami River to Cutler a few subtropical high hammocks once existed near the bayfront and at scattered positions in the adjoining pineland. Ecologists and others who have studied this group of hammocks consider them to be representative of the most tropical vegetation on the U. S. mainland. Parts of Brickell Hammock and Matheson Hammock are the best known remnants. On the opposite side of the Everglades, about forty five miles west of Miami another group of high hammocks are located in the Pinecrest area. Some ecologists have considered the latter group of hammocks to be transitional between truly temperate zone and subtropical vegetation. These two widely separated areas were studied to obtain quantitative data that would allow comparison between them and yield some information as to their subtropical or temperate zone affinities. It also provides a permanent record of quantitative data on this rapidly disappearing and unique native vegetation of the Miami area.

Davis (1943) and Harper (1927) give data on high hammocks of southern Florida. Excellent plant lists occur in these publications. However, detailed quantitative data on hammocks are not available in them as it was not a part of the objectives of these studies. Phillips (1940) made a quantitative study of Castellow Hammock in Dade County using a belt transect to produce the most detailed ecological analysis of a southern Florida hammock known to the writer.

SMITHSONIAN
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This paper presents the results of studies on mature high hammocks of the Pinecrest and Miami areas that most ecologists consider climax vegetation for southern Florida.

METHOD

In the Miami area, sites for quadrats were selected in undisturbed remnants of hammocks along the coast from Simpson Park in Miami, south to Matheson Park and inland a few miles. Since the original extent of these high hammocks is not known, hammock names will not be used for remnants except to note that Brickell Hammock was adequately sampled. A total of nineteen quadrats, each five meters square, was studied. Cain's (1938) species-area curve method indicated three such quadrats were adequate for this type of community. The larger number was used to insure sampling of many sites over a rather extensive area along Biscayne Bay.

Seven mature high hammocks in the Pinecrest area were selected as representative and in them a total of eleven quadrats, each five meters square, was studied. Cain's (1938) method indicated three such quadrats were enough to validate results. For the same reason as previously stated a larger number of quadrats was used.

Data were taken primarily on woody plants in each quadrat. Trees were listed, counted, diameters measured, and their height estimated. Shrubs were listed, counted and their heights estimated. Vines, ferns, and epiphytes were noted. Observations on canopy and seedlings were recorded. The *Check List of Native and Naturalized Trees of the United States (1953)* was used as authority for most of the scientific names.

Results and Discussion

The quantitative measurements are summarized in Tables 1 and 2. The species are listed in descending order according to their frequency. Frequency is the percentage of quadrats in which the species occurs. Density—the average number of individuals of species occurring per quadrat, is given. Dominant species have a high frequency and usually at the same time a high density rating. However, large canopy-dominating trees can have a high frequency and a low density figure.

TABLE 1

MIAMI AREA

Scientific Name	Common Name	Frequency %	Density
Coccoloba diversifolia	pigeon plum	90	3.4
Ardisia escallonioides	marlberry	90	6.3
Nectandra coriacea	lancewood	79	3.3
Eugenia axillaris	white-stopper	68	4.3
Psychotria undata	wild coffee	58	2.2
Sideroxylon foetidissimum	mastic	53	1.0
Eugenia confusa	red stopper	37	1.8
Bursera simaruba	gumbo-limbo	32	0.5
Krugiodendron ferreum	black ironwood	32	0.5
Ficus aurea	strangler fig	26	0.4
Picramnia pentandra	bitterbush	26	1.5
Quercus virginiana*	live oak*	26	0.3
Simarouba glauca	paradise tree	26	0.3
Calyptranthes pallens	spicewood	21	0.2
Dipholis salicifolia	bustic	16	0.3
Citharexylum fruticosum	fiddlewood	16	0.2
Exothea paniculata	inkwood	16	0.5
Morus rubra*	red mulberry*	16	0.2
Gymnanthes lucida	crabwood	11	0.2
Prunus myrtifolia	West-Indian Cherry	11	0.1
Metopium toxiferum	poison wood	11	0.1
Sabal palmetto*	cabbage palmetto*	11	0.2
Rivina humilis*	rouge plant*	11	0.1
Callicarpa americana*	French mulberry*	5	0.2
Chrysophyllum oliviforme	satinleaf	5	0.05
Eugenia myrtoides	boxleaf eugenia	5	0.05
Ficus laevigata	shortleaf fig	5	0.05
Piscidia piscipula	Jamaica-dogwood	5	0.05
Pithecellobium guadalupense	black bead	5	0.2
Persea borbonia*	red bay*	5	0.05
Psychotria sulzneri	wild coffee	5	0.05

* Temperate zone affinity.

In comparing the two geographical areas, it should be remembered that for calculating a species position in the list, nineteen quadrats were used in the Miami area and eleven in the Pinecrest area. The number in each case is far in excess of the quadrats needed for dependable data. Accordingly, it is felt that the lists can be examined for direct comparison. The data show thirty one species listed in the Miami area of which fourteen did not occur in the Pinecrest list. Of the twenty nine species listed for the Pinecrest area, twelve did not occur in the Miami list. In each table the species marked with an asterisk (*) were considered to be of temperate zone affinity. The remainder are restricted to subtropical Florida and the West Indian flora.

TABLE 2

PINECREST AREA

Scientific Name	Common Name	Frequency %	Density
Psychotria undata	wild coffee	91	6.8
Ardisia escallonioides	marlberry	91	8.3
Rapanea guianensis	myrsine	82	7.2
Lysiloma bahamensis	wild-tamarind	73	1.6
Nectandra coriacea	lancewood	64	1.6
Bursera simaruba	gumbo-limbo	55	1.0
Eugenia axillaris	white-stopper	55	0.8
Eugenia dicrana	nakedwood	46	5.6
Dipholis salicifolia	bustic	46	0.8
Psychotria sulzneri	wild coffee	46	0.7
Quercus laurifolia*	laurel oak	36	0.6
Metopium toxiferum	poisonwood	36	1.0
Zanthoxylum fagara	wild-lime	36	0.5
Persea borbonia*	redbay*	27	0.4
Coccoloba diversifolia	pigeon plum	27	1.4
Chrysophyllum oliviforme	satinleaf	18	0.3
Ficus aurea	strangler fig	18	0.3
Quercus virginiana*	live oak*	18	0.2
Sabal palmetto*	cabbage palm*	18	0.2
Schoepfia chrysophylloides	whitewood	18	0.3
Annona glabra	pond-apple	9	0.1
Celtis laevigata*	hackberry*	9	0.1
Chrysobalanus icaco	coco-plum	9	0.6
Erythrina arborea	coralbean	9	0.1
Eugenia confusa	red stopper	9	0.1
Exothea paniculata	inkwood	9	0.1
Ilex cassine*	dahoon*	9	0.1
Krugiodendron ferrum	black ironwood	9	0.5
Serenoa repens*	saw-palmetto*	9	0.1

* Temperate zone affinity.

The first fifteen plants in each list definitely made up the dominant tree and shrub layers. Seven species occur in both lists in the first fifteen. *Quercus virginiana* was the only temperate zone species occurring in the first fifteen of the Miami area, while *Quercus laurifolia* and *Persea borbonia* were the only temperate zone representatives in the corresponding part of the Pinecrest list. It is obvious that the high hammocks of both areas are primarily subtropical. Considering the data presented it could be argued that the Pinecrest area has more species with temperate zone affinity. However, complete plant lists of each area would show these temperate zone species in question as not restricted to the Pinecrest area. For example, *Celtis laevigata, Ilex cassine* and *Serenoa repens* are listed as if restricted to Pinecrest quadrats. These are fairly common to the Miami area studied, but the sampling technique used did not bring about their inclusion. It should also be noted that *Lysiloma bahamensis,* a tropical species, is very important as a hammock tree in the Pinecrest area. Accordingly, the data presented does not support the designation of the Pinecrest hammocks as of temperate zone affinity, nor are they decidedly different from the Miami hammocks. The main difference appears to be the larger size attained by tropical species on the east coast.

The occurrence of *Acer rubrum,* red maple and *Fraxinus caroliniana,* pop ash among the dominants in hammocks only a few miles north of the Pinecrest quadrat locations emphasizes the significance of the region to the north as the southern edge of the transition between the temperate and subtropical zones in the central part of extreme southern Florida. Further work is needed to establish the true location, extent, and nature of this zone.

LITERATURE CITED

CAIN, S. A.

1938. The Species—Area Curve. Amer. Midl. Nat. 19: 573-581.

DAVIS, J. H., JR.

1943. The Natural Features of Southern Florida. *Geological Bulletin No. 25, State of Florida,* Department of Conservation. Tallahassee.

HARPER, R. M.

1927. Natural Resources of Southern Florida. From the *18th Annual Report of the Florida State Geological Survey.*

LITTLE, E. L., JR.

1953. Check List of the Native and Naturalized Trees of the U. S., *Agric. Handbook No. 41, Forest Service,* Wash., D. S.

PHILLIPS, W. S.

1940. A Tropical Hammock on the Miami (Florida) Limestone *Ecology* Vol. 21, No. 2, pp. 166-175.

Quart. Journ. Fla. Acad. Sci. (1958), 21(4), 1959.

ECOLOGY OF THE POMPANO BEACH HAMMOCK

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Introduction

The southeast coastal area of Florida has been the site of extensive real estate developments in recent years. Due to the custom of developing huge acreages by dividing them into lots and selling them, many types of native vegetation are now nearly extinct. The first step in development has been to clear off all vegetation. In 1950 the approaching destruction of Pompano hammock became apparent and several opportunities to study this area were taken during the last eight years.

The Pompano hammock was one example of a sub-tropical plant community typical of southern Florida. Davis (1943: 148) located a Broward Co. coastal hammock as the type example as follows: Sec. 6, T 49S, R 43E. This location coincides with the hammock remanents studied and herein reported. This hammock site is of additional interest to ecologists since it represents one of the northern outposts of this type of tropical vegetation. The original extent of the hammock is unknown to the writer. In 1950 there were sizeable remanents extending from one mile south of the intersection of state roads 814 and A1A in Pompano Beach and continuing southward along A1A for about a mile. State road A1A was cut through the hammock. At one time hammock growth extended from near the beach westward to the salt water mangrove fringe along the Intra-coastal Waterway. The hammock varied in width considerably owing to the meander of the east line of the waterway. Today most of the hammock trees are gone and homes, motels and hotels occupy the site. Only a few lots are undisturbed.

One of these lots fronting on A1A and running to the Atlantic Ocean was selected as a site for detailed study in 1950. The last data were recorded from this site in 1954. Since then all native vegetation has been removed and a large apartment building occupies the entire site.

The hammock site is on a barrier-island (east of the Intra-coastal Waterway) and is therefore comparable to sites studied by Kurz (1942). His southermost site on the East Coast was Jupiter Island.

The Pompano site represents a study made about fifty miles farther south and represents a true subtropical coastal hammock. Kurz reported some extension of subtropical species as far north as Cape Canaveral. Thus, the data reported in this study extends the Kurz coverage and records some ecological factors and the floristic make-up of a near-extinct subtropical hammock.

Methods

A line transect was established in an east-west direction from the highway to the ocean. All plants on the line, including overhead canopy, were listed, their height estimated, and their contribution to the canopy noted. Other nearby hammock segments on both sides of A1A were carefully studied to enable evaluation of the data from the line transect as to its accuracy for species distribution over the entire hammock. The soil elevations along the line were determined with a hand level. The tide marks were used to establish approximately mean sea level for reference. Five stations were established on the line for the collection of environmental data. These are located by number in Figure 1 along the soil surface line.

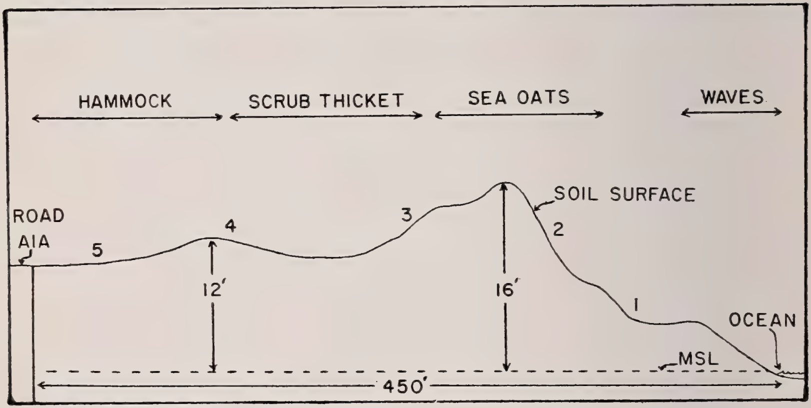

Figure 1. Diagrammatic Profile of Pompano Beach Hammock

Soil samples were taken for pH analyses, moisture analyses, available nutrients, and examination for soil type. Several sets of soil temperature readings were made with standard soil thermometers. Available nutrients were determined by rapid colorimetric methods.

To determine the moisture relationships of the air, sling psychrometer readings were made and Livingston white bulb atmometers were set up at the stations along the transect.

The names used for the woody plants occur in the check list by Little (1953). All others correspond to names in Small's Manual (1933).

RESULTS

Reference to Figure 1 will give an idea of the topography of the beach and hammock area. No related scale for vertical and horizontal lines was attempted. The total length of the transect was 450 feet and the highest dune elevation was 16 feet. The hammock occurred on soil averaging about 12 feet above sea level. On the east side the distance from the ocean to the hammock was uniform. The hammock continued on the west side of the road on fairly level land until the Intra-coastal Waterway was reached.

Table 1 gives the occurrence of the twenty one species on the part of the line transect marked "hammock" in Figure 1. The percent of the total each represented is given and the list is arranged in descending order of occurrence. The east margin of the hammock abruptly changed from hammock trees of near maximum height to scrub thicket. Inside the hammock, the tallest trees were only twenty to twenty five feet high. Occasional cabbage palms were taller. The entire hammock was dense of canopy and had a well developed shrub layer of *Eugenia myrtoides.*

The shrub thicket zone shown in Figure 1 was largely made up of *Coccoloba uvifera, Serenoa repens, Sabal palmetto,* and *Dalbergia ecastophyllum.* This thicket averaged about five feet tall and was practically impossible to penetrate without using a machete. The *Casuarina* grew here in what appeared to be an old burn.

The sea-oats zone species list was *Uniola paniculata, Sesuvium Portulacastrum, Distichlis spicata, Ipomoea Pes-Caprae, Helianthus debilis, Cenchrus* sp., and *Chamaesyce* sp.

Except for available nutrients, the data in Table 2 summarize the edaphic and climatic factors that were measured. They were all taken May 27, 1954 as a representative cloudless day and all field readings were made for an hour starting at noon. Soil temperatures were usually taken one inch below the surface of the sand. Soil moisture determinations, pH readings, and available nutrient analyses were made on random samples from the upper six inches of sand. At the time the soil temperatures given were taken, the damp sand just above the surf area was 99°F. At station 2 the sand one inch below the surface was 124°F. Three inches below the surface it was 105°F and in nearby plant shade it was 101°F one inch below the surface. In another instance it was 116°F one inch below the surface and a few inches away in the shade of one leaf it was 106°F. Similar results were obtained on other days.

TABLE 1

OCCURRENCE OF SPECIES ON THE TRANSECT

Species	Common Name	Percent
Eugenia myrtoides	boxleaf eugenia	23.0
Sabal palmetto	cabbage palm	17.0
Ardisia escallonioides	marlberry	6.0
Bursera simaruba	gumbo limbo	6.0
Eugenia axillaris	white stopper	6.0
Metopium toxiferum	poison wood	6.0
Coccoloba uvifera	seagrape	4.5
Psychotria undata	wild coffee	4.5
Casuarina equisetifolia	Australian pine	3.0
Coccothrinax argentata	silverpalm	3.0
Serenoa repens	saw palmetto	3.0
Sideroxylon foetidissimum	mastic	3.0
Zanthoxylum fagara	wild lime	3.0
Amyris elemifera	amyris	1.5
Chrysobalanus icaco	cocoplum	1.5
Krugiodendron ferrum	black ironwood	1.5
Nectandra coriacea	lancewood	1.5
Pithecellobium guadalupense	blackbead	1.5
Rivina humilis	rouge plant	1.5
Simarouba glauca	paradise tree	1.5
Torrubia longifolia	blolly	1.5

All samples of soil taken were mostly shell fragments with some sand and with organic matter ranging from none on the beach to a thin mantle in the hammock. Soil nutrients data were useful only as a rough guide of fertility. Potassium was uniformly distributed over the whole transect. Three times more phosphorus occurred in hammock soil than on the beach. Nitrate nitrogen varied from sixty parts per million in the hammock to just a trace in the beach sand. The chloride test was only a trace in the hammock soil.

TABLE 2

SUMMARY OF SOME EDAPHIC AND CLIMATIC FACTORS

	Sta. 1	Sta. 2	Sta. 3	Sta. 4	Sta. 5
Soil moisture	3.64%	0.56%	6.26%	5.26%	7.36%
Soil temperature	118°F	124°F	130°F	98°F	92°F
Soil pH	7.6	7.8	8.5	8.4	8.0
Relative Humidity	73%	67%	65%	52%	60%
Atmometer Loss	1.25 ml	1.13 ml	0.87 ml	0.73 ml	0.73 ml

Discussion

The plant list given for the transect is representative of the entire hammock. The dominance of *Eugenia myrtoides* as a uniform shrub layer averaging about five feet tall is a characteristic feature of this hammock. On the west and south sides of the hammock live oak, *Quercus virginiana* was an important marginal or pioneer tree. Throughout the hammock patches of the cactus, *Acanthocereus floridanus* occurred and usually could be seen climbing into the trees. The epiphytic orchid, *Epidendrum tampense* occurred abundantly in this hammock. Across the Intra-coastal Waterway to the west the vegetation type changed to *Pinus clausa* scrub on white sand. South of the hammock site, beach plants and scrub thicket, particularly saw palmetto constitute the plant cover.

Many isolated hammock trees left as landscape trees occur in some parts of the hammock site indicating some of the hammock grew on gently rolling old dunes. This contrasts with the extreme levelness of the hammock soil in the area of the transect.

Kurz (1942) discusses the matter of dune succession to climax vegetation and the situation of the Pompano Hammock fits the standard pattern. The data of Table 2 show no factor that would lead to the initiation of rapid changes in vegetational zonation. Oosting and Billings (1942) came to the same conclusion in their study as far as factors covered in this report are concerned. However, they also made studies of salt spray distribution. In a transect running about the same length in from the shore as that of the present study they found salt spray to be about three times greater in the foredune area than on the inside end of their transect. They concluded that the zonal distribution of the major species was related to the tolerance of the plants to wind-blown salt.

Since the hammock was growing on beach sand and shell fragments it appears that it developed in dune succession and would have slowly extended toward the east as long as new sand was brought up from the ocean and blown inward to allow dune build-up along the coast. The scrub thicket plants replaced the sea oat zone plants in normal succession. The former acted to moderate the high soil temperatures, add organic matter, and reduce the penetration of salt spray. Hammock seedlings were common along the inside edge of the scrub thicket, giving further evidence as to the origin and extension of the hammock. Comparison of the data given for stations on the transect definitely illustrates the effectiveness of the hammock cover in moderating the extremes of the beach habitat in southern Florida.

Summary

1. A transect study of near-extinct subtropical hammock is presented.
2. Plant lists and some data on ecological factors are given.
3. The Pompano site adds a new Florida beach profile study to the seven previously reported in the literature. This one differs from the others in that it is subtropical.

Literature Cited

DAVIS, JOHN H.
1943. The natural features of southern Florida. *Florida State Geol. Survey Bull.* 25, 311 pp.

KURZ, HERMAN
1942. Florida dunes and scrub, vegetation and geology. *Florida State Geol. Survey Bull.* 23, 154 pp.

LITTLE, E. L., JR.
1953. Check List of native and naturalized trees of the U.S., *Agric. Handbook No. 41, Forest Service,* Washington, D.C.

OOSTING, HENRY J., and BILLINGS, W. D.
1942. Factors effecting vegetational zonation on coastal dunes. *Ecology.* 23: 131-142.

SMALL, J. K.
1933. Manual of the Southeastern Flora (Published by the author), New York, N. Y.

Quart. Journ. Fla. Acad. Sci. (1958), 21(4), 1959.

MARRIAGE PATTERNS AMONG EVENING COLLEGE STUDENTS

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Marriage patterns and procedures among evening students in particular have been undergoing significant changes in the last generation. This is true indeed of all classes of society in some measure.

My special interest, because of my present work, lies in the problems of this special group who study in the evening. I find that they exhibit many interesting and important elements which seem to be indicative of noteworthy trends.

Edmund deS. Brunner and Sloan Wayland, writing in "The Journal of Educational Sociology" for September, 1958, pointed out what is rather generally known—that college women show the smallest percentage of married among those of their age. The poorer the education, too, the lower the standards, and the greater chance that the married woman will become a widow at an early age. The more educated, the fewer children.

This paper sums up in a cursory way a few gleanings from our own narrow field and a few others, but it may point to some interesting developments.

Among those with whom we deal at Jacksonville University—and there are now over 2000 students—there is a good deal of scattered scheduling and uncertainty as to life planning as a whole. Disconnected living patterns are due, in part, it would seem, to the fact that many veterans of military service, now trying to settle down in a job and a home, find themselves needing to get more training and more money. They find that their deficiencies in preparation cannot be ignored. This involves an entire complex pattern of adjustments which are dealt with in such volumes as "*Marriage Adjustment,*" by J. L. and Alma L. Hirning. Psychological problems are many and varied in these marriage patterns, as is evidenced in the work of George Lehner and Ella Kube, whose "Dynamics of Personal Adjustment" reveals the force, direct and indirect, which these factors can exert in and through human lives.

Probably one of the most generally readable books in this entire field is *"Personal and Social Adjustment,"* by Wayland F. Vaughan (1952).

Those who study in the evening often illustrate or symbolize some of these conditions in a vivid and arresting form. It is on this complex and fast-moving field that many new experiments in living are now being enacted.

Recent authors have called suburbanism and other influences a fragmented way of life (v. the Brunner and Sloan Wayland article, op. cit.). The circumstances of evening study produce home and marriage conditions that are even more severely thrown out of line, at times.

It is tempting to deal more extensively with these general reflections, but let me present now a few data from our very limited field and investigations. No general conclusions, of course, can be drawn from them, and they may not be at all typical.

Taking the evening student groups and examining the cases of 797 students, I find that 68 (or 8½%) failed at least one course in the second semester of the last academic year. This percentage, however, was less than that of day students. Since we do not screen entering students as severely as many other institutions do, we of course get a number who cannot last out even one semester. We also get those who are older and those who would not even try it under other circumstances. Of these who failed, 17, or 25%, were married and under 25 years of age. There were 14 married who were over 26.

Of married students now here there are 19 part-time day students 25 years of age or under and 68, 26 years of age and over. There are 137 part-time night students 25 years of age or under, and 351 who are 26 or over. Of full-time students there are 98 day who are 25 or under and 81 who are over 26. We have a total of 254 married students (who gave their age and status) who are 25 or under and 501 who are 26 or over.

It should be pointed out at once that college records clearly show that in compiling the records these married night students do achieve, they do so while also carrying on all the duties of their homes and business and do a considerable amount of community work. Their intellectual and physical output, therefore, is much greater, on the whole, than that of the day student.

Another survey conducted by students in our psychology department involved 220 students. From their reports it was evident that women were more positive about what they wanted in marriage and life, and on four out of five questionnaire lists personality was recorded as the chief trait desired in a marriage partner. Personality, maturity, or character were the most desired personal qualities. Among these it is very significant that sex appeal and physical attractiveness were far down the line.

Considerable evidence from the religious standpoint has been brought together by Albert Terrill Rasmussen, in "*Christian Social Ethics.*" These considerations, it is clear, are in the minds of the married evening student, who realizes that he must deal at one and the same time with many conflicting interests and face many moral and social issues.

In addition to these few data I should like to deal briefly with a few of the actual marriage patterns or the variations on the familiar marriage pattern.

1. Students as well as young people in general seem to be marrying earlier—for a number of reasons. There is, for one matter, a strong change in the opinion of the public on the matter of marrying before going to college or graduate school or while still enrolled in such school. This has been affected, as a pattern, by the war and by many economic and social factors—and some psychological ones.

Since there are so many who are marrying while their vocational plans and preparations are still so incomplete, the pattern of their marriage must be affected somewhat. They must budget differently and adopt different schedules concerning social activities. Their domestic life must be planned in a different way. This may set up a long chain of reactions.

2. Many are obviously trying to supplement their education after having been out of school—for one reason or another—for periods ranging up to 30 years, so far as our own records go. Many of these are "rusty" in some of their preparations—notably mathematics and English. Most of them seem to be in the lower middle class economically—and both money and time come hard to them. They are reacting to the need they see for qualifying for better jobs or for adjusting to future demands. This makes them grab for the courses which are immediately and specifically of help to

them in their vocation. I find that many of these marriages among college students of our evening group are centered largely around a temporary quest for vocational help. Cultural interests are at a dangerous minimum among many classes of student. Motivation among these individuals and homes is relatively high and genuine, but it is severely limited in scope.

Furthermore, many of these married students who work daytimes and study nights are not constructively affiliated in any way with the community. It was a great surprise to me to survey our own field through the offices of our Director of Placement and to discover to what an extent this was true. It would be thought that all of us are overorganized and overconnected—but this is apparently not so with our evening group. It *is* true, of course, that while perhaps not formally affiliated, these families and individuals keep typically busy at something. This characteristic *busyness* is itself a strong influence upon college marriages. Interruptions are constantly noted because of family or business commitments, illness, new births, trips away, and small emergencies of various types.

Many of these marriages, too, and college careers are strongly affected by the fact that these students are often exerting themselves too much. They work all day, or all night—often trying to be permitted to work full time and study full time! Their time is at a premium; their money is depleted—and many of them are almost always tired. In addition, some are tempted to try to plead for extra consideration because of their situation. This perpetual state of besiegement and overwhelming demands is both a psychological and vocational factor, and it hangs over a marriage and home, often endangering its amity and happiness and general social adjustment.

3. A natural variation of the marriage pattern is that where there is dominance of wife and mother. This the husband ordinarily hopes and expects will be temporary—but nevertheless it strongly influences marriages today. The young wife agrees to continue to work, for instance, while her husband pursues his studies, often earning relatively little during this period. There are naturally problems associated with the support, care, and supervision of the children. There is need also to keep the job going.

There is almost complete shifting of responsibility to the wife and mother.

This situation often causes the student to seek unusual arrangements with class or institution or business. He has a family or business problem, misses class or a test, for example, or is absent for several sessions—and he seeks nevertheless to get credit for his work and keep up his class status. So often it happens that a family crisis or business trip will cause a married student to miss out on his college work for two or three weeks—and this means that he may lose all. He has put in a valued investment—and he is understandably distressed that he may lose it. It happens regularly that good students, whose motivation and intelligence are high, must be absent at critical times, or find that special demands are made upon them just when it hurts most. College and business and college and family—these are not always the happiest and easiest combinations!

4. A distinctive variation in the marriage pattern is that of the student who is still benefiting from the GI Bill. About one-third of our own student body is made up of this type. He is likely to be much job-centered and money-centered, in that he wants strictly practical courses, for the most part, and he wants to get as much study-money and subsistence money as he can. He is anxious to take three courses at night, if he possibly can. He wants to take advanced courses, if he can—conveniently and scornfully vaulting over the general introductory courses!

These and other problems of marriage as they also affect the college student are detailed in such volumes as that by Judson T. and Mary G. Landis—*"Building a Successful Marriage"*—and *"Ethics for Today,"* by Harold H. Titus. Such a volume as that edited by Harry L. Shapiro also contributes much of importance to the evening student.

5. While no one of these variations should be dismissed with anything like this brevity, it may be said, in summation, that there is real indication that the joint demands of business and college and home may be having a real effect upon modern marriage and family life. There is so much rigidly planned both as to time and money, as well as in terms of required physical and intellectual effort, that the partners to the marriage do not have time for domestic and cultural matters which are of the utmost importance to

them as human beings and as those who are influencing the coming generation.

I find that it is increasingly significant that thousands do not even consider deferring a marriage until study days have increased in number. There is expectation, for instance, that scholarships and other aids will take into consideration the needs of a student's dependents as well as his own.

It may be argued—and there is conflicting evidence on the matter—as to whether marriage helps a college career. There is certainly indication enough that motivation is often increased and that greater maturity of viewpoint and experience is brought about. The individual has more to live and work for. He has also more help.

On the other hand, of course, he is beset with many liabilities and problems—financial, vocational, social, and psychological. He is subject to many interruptions and emergencies and much can interfere with the general progress of both his marriage and his studying.

The marriage pattern is also affected by the different objectives which are valued or necessary in today's world. In all probability, the increased advantages available today will in the end undergird the marriage of the college student with some stronger elements.

Marriage is not following a routine and static procedure. It is in a state of flux, with many values and forces intermingling. These are quickly and strongly reflected in the lives of those with special programs, such as the evening student.

Literature Cited

BRUNNER, EDMUND deS., and WAYLAND, SLOAN

1958. Education and Marriage. The Journal of Educational Sociology. September. Pp. 28-36.

HIRNING, J. L., and HIRNING, ALMA L.

1956. Marriage Adjustment. The American Book Company. New York. Pp. 1-23; 240-257; 279-302.

RASMUSSEN, ALBERT TERRILL

1956. Christian Social Ethics. Prentice-Hall, Inc. Englewood Cliffs, New Jersey. Pp. 29-30.

TITUS, HAROLD H.

1954. Ethics for Today. The American Book Company. New York. Pp. 67-81; 422-437; 506-518.

LEHNER, GEORGE, and KUBE, ELLA

1955. The Dynamics of Personal Adjustment. Chapters 1, 2, and 3. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

VAUGHAN, WAYLAND F.

1952. Personal and Social Adjustment. The Odyssey Press, Inc. New York. Pp. 3-32; 78-89.

SHAPIRO, HARRY L (editor)

1956. Oxford University Press. New York. Pp. 261-286.

LANDIS, JUDSON T., and LANDIS, MARY G.

1958. Building a Successful Marriage. Prentice-Hall, Inc. New York. Third Edition. Pp. 179-211; 347-377; 441-459; 589-607.

EFFECT OF CHLORTETRACYCLINE ON THE SUCCINOXIDASE AND LACTIC DEHYDROGENASE OF THE HEART OF SWINE AND CATTLE[1]

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Chlortetracycline (aureomycin) has been found to increase the growth rate of swine (Cunha *et al.* 1950) and cattle (Erwin *et al.* 1956). Stokstad (1954) discussed evidence that the antibiotic has its effect by action on the bacterial flora of the alimentary tract of animals. Chlortetracycline has been reported to have several specific actions in metabolism such as causing a decrease in aerobic phosphorylation (Loomis, 1950), a block in some part of the Krebs cycle (Van Meter and Oleson, 1951), and a decrease in succinoxidase activity of bacteria (Jacobsohn and Azevedo, 1954) and pig heart muscle *in vitro* (Aurora and Murti, 1954). Chlortetracycline has been reported to alleviate the symptoms of pantothenic acid deficiency in rats (Sauberlich, 1952) and swine (Catron *et al.* 1953; McKigney, *et al.* 1957).

The purpose of the present study was to determine the effect of chlortetracycline in (1) swine diets deficient in pantothenic acid, and (2) in fattening steer diets, on the activity of succinoxidase and lactic dehydrogenase of the heart.

Experimental

Swine: Twenty-five 5-week old weanling Duroc pigs were divided about equally (8, 8, 9) into three dietary groups according to weight, sex and litter and maintained in concrete pens. The pigs were fed a ration consisting of ground yellow corn, soybean oil meal, steamed bone meal, ground limestone, salt-trace mineral mix and various vitamins (for detailed diet see McKigney *et al.* 1957). By analysis the diet contained 3.04 mg. of pantothenic acid per pound which was inadequate for the dietary requirement of swine (McKigney *et al.* 1957). The pigs in group 1 were supplemented with 6.2 mg. of pantothenic acid, group 2 received no supplementation and those of group 3 had 10 mg. of chlortetracycline (aureomycin, Lederle) per pound of feed. All pigs were fed and watered *ad libitum.* Two or 3 pigs from each of the three dietary groups were sacrificed after 6, 9 and 12 weeks on the diets, respectively.

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Cattle: Seventeen Aberdeen Angus yearling steers weighing 462 to 470 pounds each were divided equally (5, 6, 6) into three dietary groups. Their basal diet consisted of 13.6% cottonseed meal (36% protein), 42.9% ground snapped corn, 10.7% citrus molasses and 32.8% Pangola grass hay. Groups 1, 2 and 3 were fed 0, 4.6 and 9.2 mg. of chlortetracycline per pound of basal diet, which gave them approximately 0, 10 and 20 mg. of the antibiotic per 100 pounds live weight per day. The steers were fed for 20 weeks in individual stalls before being slaughtered.

Enzyme procedures: The swine and cattle were sacrificed by bleeding and the intermuscular ventricular septum of the swine and the left ventricle of the heart of the cattle were obtained and placed immediately in a deep freeze at minus 8°C. Succinoxidase activity was determined by the manometric method of Schneider and Potter (1943) at 38°C. The lactic dehydrogenase activity was determined by the manometric method of Green and Bosteaux (1936) using adrenaline as the hydrogen carrier. Nitrogen was determined in the homogenates of the samples by the Kjeldahl method. The activities of both enzymes were calculated as ml. (milliliters) of oxygen uptake per mg. (milligram) of N (nitrogen) per hour, and per gram of wet weight per hour.

Results and Discussion

Data presented in Fig. 1 were obtained for the effect of dietary chlortetracycline on the succinoxidase and lactic dehydrogenase activity of the heart of swine and cattle. The values for activity on the per mg. of N basis have been multiplied by 10 in order to plot them on the graph. The intermuscular ventricular septum of the swine hearts contained 2.68±0.15% N compared to 2.19±0.04% N for the left ventricle of the cattle hearts on the basis of wet weight. The swine and cattle fed the antibiotic had greater succinoxidase activity than the controls; however, the differences were not statistically significant. The heart of the swine had about 30% more succinoxidase activity than the cattle on the basis of wet weight, and 15% more activity on the basis of per mg. of N present.

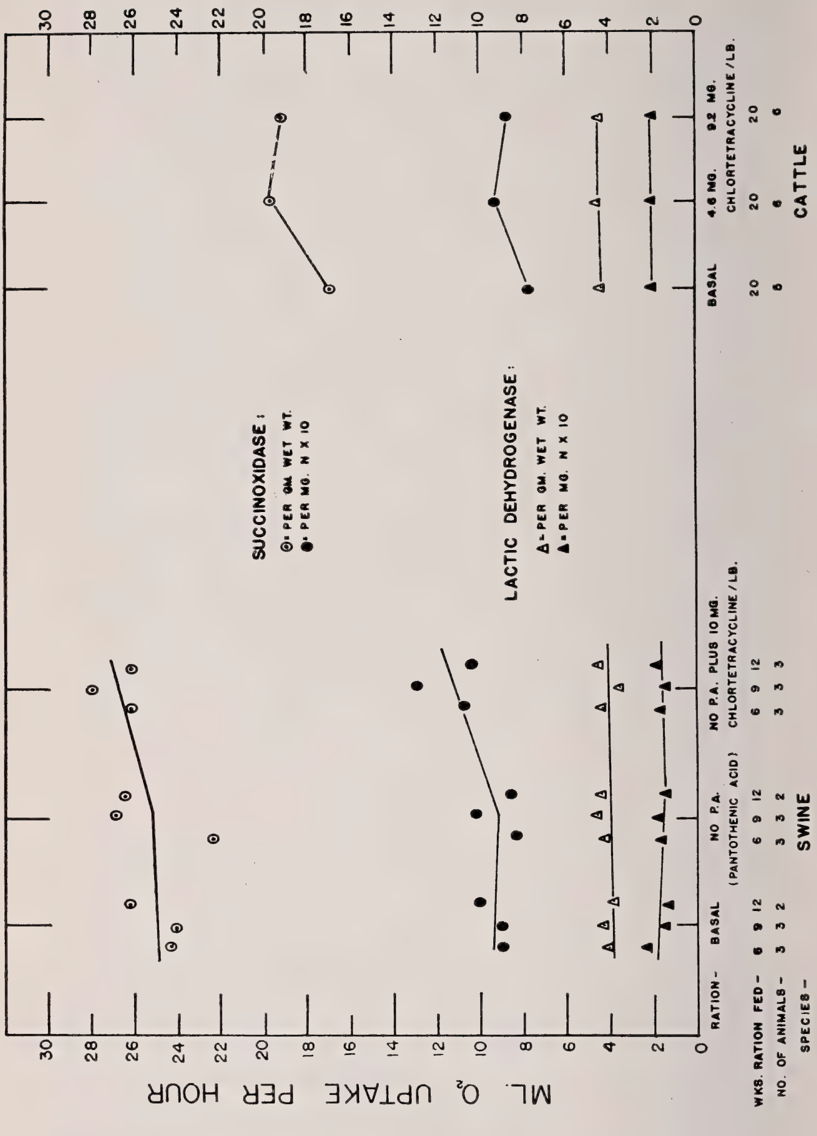

Figure 1. Effect of chlortetracycline on the succinoxidase and lactic dehydrogenase activity of the heart of swine and cattle.

The chlortetracycline had no effect on the lactic dehydrogenase of the heart of the swine and cattle on either the wet weight or the per mg. of N basis. The cattle had somewhat greater lactic dehydrogenase activity than the swine, which was the reverse of that observed for succinoxidase activity (see above). The cattle had about 8% and 22% more lactic dehydrogenase activity in the heart than the swine on the wet weight and per mg. of N basis, respectively.

Feeding the diet deficient in pantothenic acid had no effect on the succinoxidase and lactic dehydrogenase of the heart of the swine. The number of weeks that the swine were fed the diets had no effect on the activity of either enzyme.

These observations indicate that the widely used chlortetracycline antibiotic has no effect on the activity of two very important enzyme systems of the heart of swine and cattle when used over an extended period of time. The study also demonstrates some differences, but a great similarity in enzyme activity in the heart of swine and cattle.

SUMMARY

Chlortetracycline (aureomycin), when fed to 5-week old swine for 6 to 12 weeks and yearling steers for 20 weeks, had no significant effect on the succinoxidase and lactic dehydrogenase activity of the heart.

The heart of the swine had about 30% and 15% more succinoxidase activity than the cattle on the wet weight and per mg. of N basis, respectively.

The cattle had about 8% and 22% greater lactic dehydrogenase activity in the heart than the swine on the wet weight and per mg. of N basis, respectively.

Diets low in pantothenic acid had no effect on succinoxidase and lactic dehydrogenase activity of the heart of the swine.

ACKNOWLEDGMENTS

The writers wish to thank J. F. Easley, J. W. Carpenter and A. Z. Palmer for technical assistance in this study. This study was financed in part by a grant-in-aid from the American Heart Institute, Bethesda, Maryland.

Literature Cited

ARORA, K. L., and C. R. K. MURTI
1954. Enzyme inhibition studies in relation to drug action. VI. Action of certain antibacterial agents on the succinoxidase system. J. Sci. Ind. Res. (India) 13B, 482-487.

CATRON, D. V., R. W. BENNISON, HELEN M. MADDOCK, G. C. ASHTON, and P. G. HOMEYER
1953. Effects of certain antibiotics and vitamin B_{12} on pantothenic acid requirements of growing-fattening swine. J. Ani. Sci. 12: 51-61.

CUNHA, T. J., J. E. BURNSIDE, G. B. MEADOWS, H. M. EDWARDS, R. H. BENSON, A. M. PEARSON, and R. S. GLASSCOCK
1950. Effect of aureomycin fermentation product supplement on the efficiency of feed utilization for the pig. Ibid 9: 615-618.

ERWIN, E. S., I. A. DYER, and M. E. ENSMINGER
1956. Effects of chlortetracycline, inedible animal fat, stilbestrol, and high and low quality roughage on performance of yearling steers. Ibid 15: 710-716.

GREEN, D. E., and JEANNE BROSTEAUX
1936. The lactic dehydrogenase of animal tissues. Biochem. J. 30: 1489-1508.

JACOBSOHN, K. P., and M. D. AZEVEDO
1954. Action of several antibiotics on bacteria dehydrases and fumaric hydratase. Compt. rend. soc. biol. 148: 1712-1714.

LOOMIS, W. F.
1950. Mechanism of action of aureomycin. Science 111: 474.

McKIGNEY, J. I., H. D. WALLACE, and T. J. CUNHA
1957. The influence of chlortetracycline on the requirement of the young pig for dietary pantothenic acid. J. Ani. Sci. 16: 35-43.

SAUBERLICH, H. E.
1952. Effect of aureomycin and penicillin upon the vitamin requirement of the rat. J. Nutrition 46: 99-108.

SCHNEIDER, W. C., and V. R. POTTER
1943. The assay of animal tissues for respiratory enzymes. J. Biol. Chem. 149: 217-227.

STOKSTAD, E. L. B.
1954. Antibiotics in animal nutrition. Physiol. Revs. 34: 25-51.

VAN METER, J. C., and J. J. OLESON
1951. Effect of aureomycin on the respiration of normal rat liver homogenates. Science 113: 273.

Quart. Journ. Fla. Acad. Sci. (1958), 21(4), 1959.

OBSERVATIONS ON THE ECOLOGY OF A NEW POPULATION OF THE MEDITERRANEAN GECKO, HEMIDACTYLUS TURCICUS, IN FLORIDA

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University of Florida

The Mediterranean gecko, *Hemidactylus turcicus turcicus* Linnaeus, was reported from Florida at Key West by Stejneger in 1922 (Copeia, 1922(108): 56). Later Barbour (Copeia, 1936(2): 113) reported it from the vicinity of Miami. Specimens of this lizard were first collected in Gainesville, Florida, on 25 October 1956. The geckos were found in a wood frame building, which was being dismantled, on the University of Florida campus. On 15 March 1957, J. M. Pylka and I collected 34 of these lizards from the outside walls of other frame buildings in the vicinity. Twelve specimens were collected on 25 April 1957, and three on 9 May 1957. W. J. Riemer collected a series of 44 specimens from the same buildings on 9 August 1958. Students from southern Florida or from one of the Caribbean countries may have introduced the lizards, or they may have been released by some herpetologist

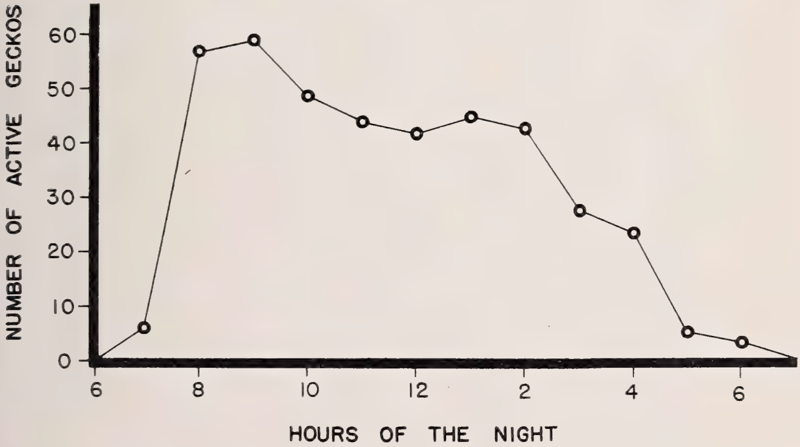

Figure 1. Approximate nocturnal activity of the Mediterranean gecko, Hemidactylus turcicus, recorded in Gainesville, Florida, during July 1957.

formerly in the university. All of the specimens have been placed in the University of Florida Collections.

The largest male and the largest female had snout-vent lengths of 59 mm. The smallest juvenile had a snout-vent length of 25 mm.

Observations were made during the month of July, 1957, in order to determine the activity cycle of the lizards. Tours of the buildings were made at hourly intervals. The number of lizards seen on each tour was counted, and the period of greatest activity was determined to be one to three hours after sunset. The number of active individuals slowly decreased after this period until all had disappeared shortly before sunrise. This is shown in figure 1. During the daylight hours they remained hidden in cracks around window frames and beneath the flashing of the asbestos siding.

On the night of 12 July 1957 a mating pair was observed on the wall of one of the buildings. When mating began the two were facing each other. The male moved toward the female and grasped her skin at midback with his jaws. In this position the body of the male partially covered the head of the female. By sidestepping, the male to the right and the female to the left, the two brought their bodies into contact. The male then placed his right hindleg over the tail of the female, but twisted his tail under hers. This brought the cloacae into contact. The total time lapse from the moment the male approached the female to the point at which copulation began was approximately two minutes. Copulation lasted about one minute, then the male left the female and darted up the wall. The female licked her cloaca several times and then she also darted up the wall.

Gravid females with mature eggs in their oviducts were both collected and observed on the buildings throughout the spring and summer months (April through August). This may indicate a five month breeding season similar in length to the breeding season of *Anolis carolinensis* reported by Hamlet (Copeia, 1952(3): 183). Captive females laid eggs on 4 May and 22 May 1957. The eggs measured 12 mm. in length and 9 mm. in diameter.

AWARENESS OF FLORIDA COLLEGE STUDENTS OF THE STATE NUCLEAR PROGRAM[1]

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Florida State University

Introduction

Nuclear power gives promise of becoming an important new resource for the generation of electricity and for varied industrial and other purposes. In Florida, a state in which conventional fuel costs are relatively high, a special incentive exists for an aggressive attitude in developing the new source of power. Governor LeRoy Collins has taken the initiative in emphasizing the advantages to the state in developing nuclear power. Also, in 1957 the State Legislature passed the Nuclear Development Act (Senate Bill No. 176) which appropriated more than $5,000,000 for buildings, laboratories, and equipment for nuclear research to be conducted at the state universities. The program has started auspiciously. Several months ago the head of the Florida Nuclear Development Commission was able to state that Florida currently leads the South in nuclear developments.[3]

Is the average Floridian aware of these trail-blazing occurrences? What reactions does he have? What social changes does he anticipate based on the nuclear developments? These questions are of some importance since nuclear activities may signal a new era in industrial development. These questions are likewise of importance for the reason that, despite advantages and opportunities associated with nuclear energy, some hazards do exist. Radiation hazard is of special importance. People might conceivably be sufficiently concerned over these hazards so as to be uninterested in employment in nuclear industries. However, it is to be noted that the U. S. Atomic Energy Commission has recently stated the probability of occurrence of publicly-hazardous accidents in nuclear power reactor plants to be "exceedlingly low."[4] Nevertheless it seems desirable to probe public reactions to the new development of nuclear energy.

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[1] This study is part of a larger project which was supported by grants from the Florida State University Research Council and the Florida Inter-Institutional Committee on Nuclear Studies and Research. Other aid was rendered by the Florida Nuclear Development Commission and the Center for Social Research, FSU.

[2] Department of Sociology, Florida State University.

[3] *Tampa Tribune,* May 7, 1958.

Probing the public mind is a matter that lies in the domain of social science. This paper is based on a questionnaire mailed to Florida college students as described below. The questionnaire sought to appraise (1) the extent of knowledge of each student regarding the Florida Nuclear Development Act and (2) the student's attitudes towards industrialization in general and toward the use of nuclear energy in particular. A similar study is now in process of being completed dealing with the knowledge and attitudes of a sampling of *adults* in Florida toward nuclear developments.

RESEARCH DESIGN

The population sampled in this present study consists of a ten per cent random sample of freshman and senior college students enrolled in six Florida colleges: the University of Florida, Florida State University, Florida A & M University, the University of Miami, Stetson University, and the University of Tampa. A total of 1,456 questionnaires was mailed out to the entire student group. Of this number, the students returned 650 by mail. The colleges returned 291 of the questionnaires to us, with the notation that the students had dropped out of school. This left 515 students to be contacted. Student interviewers in each college contacted the non-respondents. In this way 320 of the 515 non-respondents were interviewed and they filled out the questionnaire. Based on the 320 questionnaires obtained by individual interview, no appreciable difference was found to exist between the mail respondents and the non-respondents in their answer to questions relating to their awareness of the Florida nuclear developments.

AWARENESS OF THE NUCLEAR PROGRAM

Except for one provision, approximately ninety per cent of the students in this sample were completely unaware of the Florida

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[4] See *Theoretical Possibilities and Consequences of Major Accidents in Large Nuclear Power Plants* (Washington, D. C., U. S. Atomic Energy Commission, (1957), p. 3.

Nuclear Development Act. The one exception was the knowledge that the three State Universities are participating in the program. It was also quite clear that the amount of formal education made little difference in their awareness of the provisions of this act as there were no differences between the freshmen and seniors in their answers.

TABLE I

PER CENT RESPONSE TO QUESTION, "DOES THE FLORIDA ACT ESTABLISH GOVERNMENTAL CONTROL OF NUCLEAR ENERGY AT THE STATE LEVEL JUST AS THE UNITED STATES ATOMIC ENERGY COMMISSION DOES AT THE NATIONAL LEVEL?" BY FRESHMAN AND SENIOR CLASS.

Class	Per Cent Aware that the Governmental Responsibility is Different	Per Cent Unaware of the Difference
Freshman	5.2	94.8
Senior	6.9	93.3

TABLE II

PER CENT RESPONSE TO QUESTION, "ARE THE STATE UNIVERSITIES SUCH AS THE UNIVERSITY OF FLORIDA, FLORIDA STATE UNIVERSITY, AND FLORIDA A. & M. UNIVERSITY INVOLVED IN THE STATE NUCLEAR PROGRAM?" BY FRESHMAN AND SENIOR CLASSES.

Class	Per Cent Aware of University Participation	Per Cent Unaware of University Participation
Freshmen	51.8	48.2
Seniors	69.1	30.9

Even though the majority of the students failed to identify any of the specific provisions of this act, eighty per cent of them endorsed the present program both in broad outline and in method of financing, when its provisions were presented to them with no label.

POSITIVE FEATURES OF NUCLEAR DEVELOPMENT

In spite of the fact that the students were unaware of the State's effort in the field of nuclear development, many of them were alert to the advantages which might be derived from the constructive use of this power. Prominent among these advantages were high standard of living, increased job opportunities, and increased industrialization. One of these three was mentioned in sixty-one per cent of the replies. Eleven per cent of the replies indicated that the main importance of this development would be derived from its utilization in medical and agricultural research.

TABLE III

DISTRIBUTION OF RESPONSES TO QUESTION, *"WHAT POSITIVE OR DESIRABLE THINGS OCCUR TO YOU IN CONNECTION WITH THE DEVELOPMENT OF NUCLEAR ACTIVITIES IN FLORIDA?"*

Category	Per Cent of Total Responses
Higher Standard of Living	44.9
Increased Industrialization	16.8
Advance in agriculture and medical research	11.3
Increased interest in this field would lead to teaching of course in college to prepare for new occupations in this field	7.3
Don't know	6.8
Encourage people to move to Florida	6.3

NEGATIVE FEATURES OF NUCLEAR DEVELOPMENT

Although it is important to understand how the population feels concerning the positive features, the greatest resistance will come from those who see undesirable implications from the use of nuclear energy. However, one has to note that approximately thirty per cent of our sample were not sufficiently informed about nuclear energy so as to discuss the undesirable features. The questions raised most frequently concerning health hazards centered around (1) problems of disposal of waste material and radioactivity, and (2) the question of the increased strategic (military) importance of Florida if nuclear development is stressed.

Plant Location and Employment

A test of whether the negative features outweigh the positive is seen in the way people actually welcome nuclear plants in their own community. From these returns it seems that the majority of students would welcome these plants. However, thirteen per cent feel concerned about the location of such a plant in their community. Another seventeen per cent are relatively indifferent to this development.

Individual acceptance is closely related to community acceptance as indicated by the student replies to the question, "Would you like to work in a nuclear plant?" Seventy per cent indicated their willingness as compared to eleven per cent who would refuse such employment. Nineteen per cent were undecided as to what their decision would be.

TABLE IV

DISTRIBUTION OF RESPONSES TO QUESTION, *"DO ANY PROBLEMS OR NEGATIVE FEATURES OCCUR TO YOU IN CONNECTION WITH NUCLEAR DEVELOPMENTS IN FLORIDA?"*

Category	Per Cent of Total Responses
Don't know	33.4
Health-disposal problems	18.5
Increase in strategic importance of Florida in case of war	15.6
Damage to natural resources	6.8
Cost of program	6.5
Damage to cities	5.7

The specific hazard of radioactivity does not seem to be important to the students in our sample (however scientists may argue about it), as eight-five per cent said they would not be especially worried about radioactivity in plants located in their community.

Measure of Awareness or Knowledge Concerning Nuclear Subjects

One of the significant contributions of this study is the development of a general measure of knowledeg concerning nuclear

TABLE V

PER CENT DISTRIBUTION OF CORRECT RESPONSES ON QUESTIONS RELATING TO SPECIFIC ASPECTS OF THE FLORIDA NUCLEAR ACT BY LEVEL OF KNOWLEDGE OF NUCLEAR SUBJECTS

Question	Per Cent Correct Answer With High Score on Knowledge of Nuclear Subjects	Per Cent Correct Answer With Medium Score on Knowledge of Nuclear Subjects	Per Cent Correct Answer With Low Score on Knowledge of Nuclear Subjects
"Does the Florida Act establish governmental control of nuclear energy at the state level just as the U. S. Atomic Energy Commission does at the National level?"	9.0	4.0	.5
"Does the Florida Nuclear Act provide Funds for Nuclear Research to private colleges and universities within Florida?"	12.0	9.7	3.4
"Are the State Universities such as the University of Florida, Florida State University, and Florida A. & M. University involved in the State Nuclear Program?"	64.5	53.6	44.8

subjects. The technical details concerning its construction are described in a paper presented at a meeting of the Southern Sociological Society in April, 1958. (Francis R. Allen and Charles M. Grigg, "The Community and Industrialization: Attitudes Toward the Use of Nuclear Power.") The importance of this measure is that it is related to the student's awareness of the Florida Nuclear Act as well as his attitudes toward the use of nuclear power as a source of energy.

Table 5 summarizes the relationship between the measure of knowledge of nuclear subjects and their awareness of specific aspects of the Florida Nuclear Act. In all cases those students with the highest knowledge scores were more aware of the provisions of the "act".

The consistency of the above responses is shown again in Table 6, where the score on the measure of knowledge of nuclear subjects is related to the question which gives the purposes of the "act" without identifying it as such. This finding is the most encouraging of the study, in that it points up the fact that those students who have the most knowledge about nuclear developments are more favorably disposed toward the program.

TABLE VI

PER CENT DISTRIBUTION OF RESPONSES ON QUESTION *"WHAT WOULD BE YOUR REACTION TO A STATE PROGRAM DESIGNED TO ENCOURAGE THE USE OF NUCLEAR ENERGY BY PRIVATE INDUSTRIES AND TO FOSTER THE TRAINING OF SKILLED NUCLEAR PERSONNEL BY THE STATE UNIVERSITIES?"* BY LEVELS OF KNOWLEDGE OF NUCLEAR SUBJECTS

	Strongly favor	Favor	Indifferent	Opposed
High Score	60.0	32.6	4.5	2.9
Medium Score	45.0	43.5	8.0	3.5
Low Score	30.0	51.6	15.0	3.4

ATTITUDES TOWARD INDUSTRIALIZATION

When the student's response to the question, "Do you favor an increase in industrialization in Florida?" is related to their score on knowledge of nuclear subjects, more of the students with the highest score are in favor of an industrialized state than those with lower scores.

TABLE VII

PERCENTAGE DISTRIBUTION OF RESPONSES TO QUESTION, "*IF A NUCLEAR POWER PLANT WERE ESTABLISHED IN YOUR OWN COMMUNITY, WOUD YOU BE (1) VERY HAPPY AND PROUD CONCERNING THIS OCCURRENCE, (2) RELATIVELY INDIFFERENT, OR (3) FEEL CONCERNED OR WORRIED IN ANY WAY?*" BY SCORE ON SCALE OF KNOWLEDGE OF NUCLEAR SUBJECTS

Score on Knowledge Test	RESPONSE TO QUESTION		
	Favorable	Indifferent	Unfavorable
High	76.5	16.3	7.2
Medium	65.9	17.2	16.8
Low	62.5	20.0	17.5

TABLE VIII

PERCENTAGE DISTRIBUTION OF REPLIES TO QUESTION, "*IF YOUR OWN SKILLS WERE OF A TECHNICAL OR ENGINEERING NATURE (PLEASE ASSUME FOR THE MOMENT THAT THIS IS TRUE), WOULD YOU LIKE TO WORK IN A NUCLEAR PLANT?*" BY SCORE ON SCALE OF KNOWLEDGE OF NUCLEAR SUBJECTS

Score on Knowledge Test	RESPONSE TO QUESTION		
	Yes	No	Don't Know
High	80.9	5.8	13.3
Medium	66.5	12.2	21.3
Low	49.4	10.8	39.8

The data contained in Table 7 and Table 8 point to a similar relationship between the student's score and answers to their attitudes toward location of a nuclear power plant in their community and whether they would work in a nuclear plant. In both instances the better informed student was more favorably disposed to both situations. The final question, which asks, "If a nuclear plant were established in your community, would you be especially worried about hazards due to radioactivity?", follows the same pattern when related to the student's knowledge of nuclear subjects. Fewer of the students in the high-score category expressed concern about the hazards of radioactivity than did the medium or low scorers.

Summary of Findings

The analysis of this sample of college students points to certain findings which should be of importance for the continuation of the present program as well as for any anticipated expansion. The interpretation of the responses is divided into four categories.

The first relates to the dissemination of the aims and purposes of the original act.

(a) The analysis of these data indicates that the college population is not familiar with the present program in Florida.

(1) This lack of knowledge is not only present at the rather general level of aims and goals, but extends to the specific role of each of the state universities in the program. (This is an area about which you would expect the college student to know most.)

(2) From the results of this study it would seem that the better informed student would give his support to the expressed aims and goals of the program if he were aware of them.

The second group of findings relates to the student's perception of advantages and disadvantages which might be derived from a nuclear program in Florida.

(a) Most of the students perceive only economic advantages from the program, with only a few conscious of such advantages as might be derived from it in agriculture, medicine, or from the increased research facilities in physics, chemistry, and related areas at the state universities.

(b) The negative aspects of nuclear development within the state center around the problem of waste disposal with a small percentage of the students apprehensive about the increased strategic importance of Florida in case of war.

A third area relates to the student's general attitude toward industrialization and, specifically, his attitudes toward the use of nuclear power.

(a) It is clear that most students favor a more industrialized Florida, and the majority of students have no fear of living in a community or working in a plant using nuclear power.

The fourth and final area is concerned with factors relating to the above three areas.

(a) The responses in the other three areas were in no way related to sex, amount of education, or by place of residence.

(b) The one factor which proved meaningful in analyzing both knowledge of the present nuclear program and attitudes toward industrialization was the measure constructed for this study which we have called knowledge of nuclear subjects. This measure was related to both their knowledge of the nuclear program as well as their attitude toward industrialization and use of nuclear power in the community.

FURTHER NOTES ON TREMATODA ENCYSTED IN FLORIDA MULLETS[1]

ROBERT F. HUTTON AND FRANKLIN SOGANDARES-BERNAL
Florida State Board of Conservation Marine Laboratory[2]

Welberry and Pacetti (1954) reported *Heterophyes heterophyes* from the stool of a Florida child. Since they did not mention finding adult trematodes their identification appears to have been made on ova contained in the stool. They have stated that the ova measured 30 x 17 microns, were operculate and contained a developed miracidium. This description agrees with that of the ova of *H. heterophyes.* Hutton (1957) pointed out that this identification was subject to error. Welberry and Pacetti (*loc. cit.*) suggested that the black mullet, *Mugil cephalus,* was the source of infection of the child mentioned above. Hutton (*loc. cit.*) reported examining Florida mullet (*Mugil cephalus* and *M. curema*) from various areas of the State. He found the metacercarial stage of two species of Trematoda. After carrying out feeding experiments with a variety of animals one species was identified as *Phagicola longa* (Ransom, 1920) Price, 1932. The other species was listed as a strigeid trematode. Hutton and Sogandares-Bernal (*in press*) reported the Brown Pelican, *Pelecanus occidentalis,* and the American Egret, *Casmerodius albus,* as natural definitive hosts for *Phagicola longa* (Fig. 1) in Florida. *Mugil cephalus, M. curema* and *M. trichodon* were listed as second intermediate hosts. We reported finding *Mesostephanus appendiculatoides* (Price, 1934) Lutz, 1935, (Fig. 2) from the same three species of mullet listed above. We were able to obtain adult worms from the intestine of laboratory-raised opossums, *Didelphis virginianus,* and one of two laboratory-raised Black-crowned Night Herons, *Nycticorax nycticorax.* The Brown Pelican was listed as a natural definitive host for *M. appendiculatoides. Cerithium muscarum,* a common Florida marine snail, contains a cyathocotyle cercaria which we believed to be the larva of *M. appendiculatoides.*

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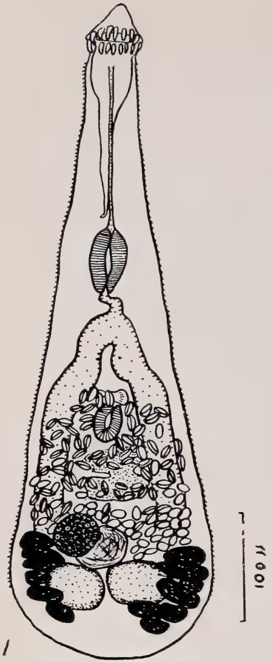
[1] This investigation supported in part by a research grant, E-1447(C), from the National Institutes of Health, U. S. Public Health Service, Bethesda 14, Maryland.

[2] Contribution No. 20 from The Florida State Board of Conservation Marine Laboratory, St. Petersburg, Florida.



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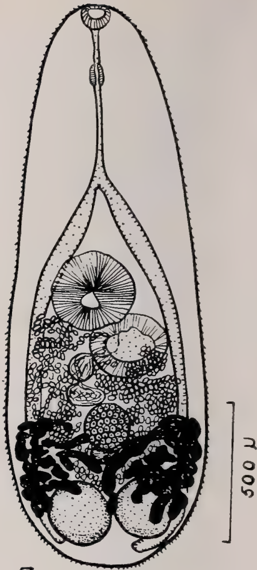

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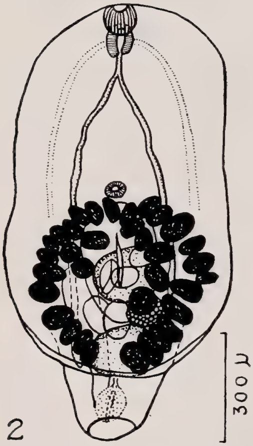

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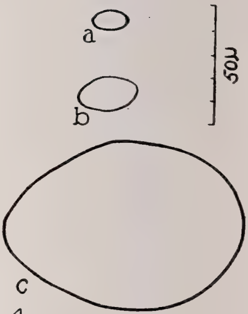

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Figure 1. Adult, *Phagicola longa* (Ransom, 1920) Price, 1932, ventral view, from American egret.

Figure 2. Adult, *Mesostephanus appendiculatoides* (Price, 1934) Lutz, 1935, ventral view, from brown pelican.

Figure 3. Adult, *Heterophyes heterophyes* (Siebold, 1852) Stiles and Hassall, 1900, ventral view (modified from Witenberg, 1929).

Figure 4. Eggs:

a. Phagicola longa.
b. Heterophyes heterophyes.
c. Mesostephanus appendiculatoides.

Burton (1958) reviewed the taxonomy of the trematode genera *Ascocotyle* Looss and *Phagicola* Faust. The extent of the vitellaria is considered by Burton as well as other workers as the only valid character separating these two genera. Stunkard and Haviland (1924) in the original description of *Ascocotyle (Phagicola) diminuta* stated: "The oral sucker is surrounded by a crown of spines, about sixteen in number, arranged in a single row." Stunkard and Uzmann (1955) redescribed *Ascocotyle (Phagicola) diminuta* reporting a single row of sixteen spines and two dorsal accessory spines in the oral crown. Burton (1958) was unaware of the work by Stunkard and Uzmann, thus, an error resulted in the placing of *P. diminuta* in his key to the North and South American species of the genus *Phagicola*.

Hutton and Sogandares-Bernal (1958) recognized *Ascocotyle* Looss, *Phagicola* Faust and *Parascocotyle* Stunkard and Haviland as valid genera at least until life cycle studies would prove otherwise. A key to the three genera was constructed by these workers. *Ascocotyle sensu stricto* was recognized as having vitellaria extending forward as far as the acetabulum and with two complete rows of oral spines; *Phagicola sensu stricto* has vitellaria extending forward only to the ovary, never beyond, and a single complete row of oral spines; and, *Parascocotyle sensu stricto* has vitellaria extending forward only to ovary, never beyond, and a single complete row of oral spines; and an incomplete second row of from 2 to 4 accessory spines. The fact that one species, *Ascocotyle* (*Phagicola*) *angeloi* Travassos, 1928, although having vitellaria extending to the level of the ovary, has two rows of oral spines was overlooked. The key to the above genera is therefore revised as follows:

1. Vitellaria extending as far forward as acetabulum .... *Ascocotyle, sensu stricto*
1.-- Vitellaria extending forward only to ovary, never beyond 2
2. With a single complete row of oral spines .... *Phagicola, sensu stricto*
2.-- With a double row of oral spines or a single complete row and an incomplete second row .... *Parascocotyle, sensu stricto*

According to the above key *Ascocotyle* (*Phagicola*) *angeloi* Travassos is placed in the genus *Parascocotyle*.

Many workers will disagree with the placing of *Phagicola* and *Parascocotyle* in separate genera and it is possible that future work will show conclusively that *Parascocotyle* as well as *Phagicola* are not valid genera. However, until that time, since not one life cycle has been worked out for *Ascocotyle, Phagicola* or *Parascocotyle,* we choose to consider them as separate genera. From the phylogenetic standpoint *Parascocotyle* may be considered closely allied to *Phagicola* in that in both genera the vitellaria never extend beyond the ovary. However, the second row of oral spines in *Parascocotyle* may indicate an intermediate phylogenetic link between *Ascocotyle* and *Phagicola.*

During the years 1956, 1957 and 1958 the flesh and hearts of over 2400 specimens of Florida mullet were examined for larval trematodes. Numerous feeding experiments using a variety of reptiles, birds and mammals were carried out. At no time were any worms recovered that could have been *Heterophyes heterophyes.* On one occasion a single acanthocolpid metacercaria was found encysted in the posterior part of a mullet near the caudal peduncle. Hopkins (1954) reported the metacercariae of *Rhipidocotyle lepisostei* Hopkins as being abundant in the fin rays of mullets, *Mugil cephalus* and *M. curema.* Furthermore, he states: " . . . In very small mullets the encysted metacercariae are in the gill region or in the body cavity; in larger mullets most of the encysted metacercariae are inside of the rays of the fins, especially the caudal fin; very large mullets usually do not contain any metacercariae."

Table I shows a comparison of the egg sizes of *Heterophyes heterophyes, Phagicola longa* and *Mesostephanus appendiculatoides.* From the measurements given in this table it is evident that the eggs of *M. appendiculatoides* are approximately three times the size of those of *H. heterophyes* while the eggs of *P. longa* are slightly more than half the size of those of *H. heterophyes.* Because of the great size differences there seems to be little chance that the eggs of one of the above three species would be confused with either of the others. The available evidence indicates that it is very unlikely that *H. heterophyes* occurs in Florida waters because (1) the adult stage of the worm has never been reported in native Floridians, (2) numerous animals (mammals, birds and fishes) from Florida have been examined for trematodes by various workers and the parasite has not been reported, and (3) our work indicates that the parasite does not occur in Florida mullets even though *Mugil cephalus*, a second intermediate host for *H. heterophyes* in endemic areas, is the most common mullet in Florida waters.

TABLE I

A COMPARISON OF THE EGG SIZES OF *HETEROPHYES HETEROPHYES, PHAGICOLA LONGA,* AND *MESOSTEPHANUS APPENDICULATOIDES*

Species	Measurements in Microns	According To:
H. heterophyes	26- 30 x 15-17	Dawes (1956)
P. longa	18 x 9	Witenberg (1929)
M. appendiculatoides	80-112 x 60-80	Price (1934)

There remains the possibility that even though *H. heterophyes* appears to be absent in Florida waters the parasite could complete its life cycle in native animals. Definitive hosts (man, dog, cats, etc.) and a second intermediate host (*Mugil cephalus*) are present. It remains to be determined if a suitable first intermediate host is present. A definitive host from an endemic area could transport the parasite into the State. If suitable snails are available in Florida waters and they come in contact with the ova of the parasite there is little doubt that the life cycle would reach completion, especially because of the ubiquity of Florida mullet.

Literature Cited

BURTON, P. R.

1958. A review of the taxonomy of the trematode genera *Ascocotyle* (Looss) and *Phagicola* (Faust) of the family Heterophyidae. *Proc. helm. Soc. Wash.,* **25**(2): 117-122.

HOPKINS, S. H.

1954. The American species of trematode confused with *Bucephalus* (*Bucephalopsis*) *haimeanus*. *Parasit.,* 44(3 and 4): 353-370.

HUTTON, R. F.

1957. Preliminary notes on Trematoda (Heterophyidae and Strigeoidea) encysted in the heart and flesh of Florida mullet, *Mugil cephalus* L. and *M. curema* Cuvier and Valenciennes. *The Bulletin, Dade County Med. Assoc.,* (March), 2 pp.

HUTTON, R. F., and SOGANDARES-BERNAL, F.
1958. Variation in the number of oral spines of *Phagicola longicollis* Kuntz and Chandler, 1956, and the description of *P. inglei* n. sp. (Trematoda: Heterophyidae). *J. Parasit.,* **44**(6): 627-632.

HUTTON, R. F., and SOGANDARES-BERNAL, F.
In press. Studies on helminth parasites from the coast of Florida. II. Digenetic trematodes from shore birds of the west coast of Florida. 1. *Bull. Mar. Sci. Gulf and Caribbean.*

STUNKARD, H. W., and HAVILAND, C. B.
1924. Trematodes from the rat. *Amer. Mus. Novit.,* No. 126: 1-10.

STUNKARD, H. W., and UZMANN, J. R.
1955. The killifish, *Fundulus heteroclitus,* second intermediate host of the trematode, *Ascocotyle* (*Phagicola*) *diminuta. Biol. Bull.,* **109**: 475-483.

WELBERRY, A. E., and PACETTI, W.
1954. Intestinal fluke infestation in a native Negro child. *The Bulletin, Dade County Med. Assoc.,* (January), pp. 34 and 45.

Quart. Journ. Fla. Acad. Sci. (1958), 21(4), 1959.

MORPHOLOGICAL AND BIOCHEMICAL STUDIES ON THE ORGANISM *SPHAEROTILUS NATANS* [1, 2]

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The organism *Sphaerotilus natans* Kützing, is quite important from a socio-economic point of view. It has caused trouble in streams containing effluents from the paper pulp industry by producing slime problems (Lackey, 1945). The organisms have also been implicated in the bulking of activated sludge in sewage treatment plants (Hoyle, 1927). This study was made so that more information might be amassed concerning its nutritive requirements and morphological characteristics.

Morphological and growth studies were made on five different media which supported the growth of *Sphaerotilus*. A total of fifteen pure culture strains were used in these tests; each strain was individually tested. The fifteen strains were obtained from five different sources including those isolated from sewage treatment plants and paper mill wastes.

Microscopic examination of the organism both in wet mounts and stained slides revealed the following characteristics conforming to descriptions in Bergey's *Manual* of *Determinative Bacteriology* (1957). *Sphaerotilus* is a gram negative filamentous type organism. The individual filaments are composed of trichomes of bacterial cells held together by a slimy colorless sheath. Multiplication occurs through the formation of conidia (the reproductive cells) which are simply vegetative cells broken loose from a filament. The conidia swim out from the sheath, attach themselves and subsequently develop into trichomes.

The cultural characteristics of *Sphaerotilus* were initially studied on a medium devised by J. L. Stokes (1954). The medium is composed of glucose, peptone, $MgSO_4$, $CaCl_2$, and $FeCl_3$. The growth obtained on this agar was good and was characterized by outgrowths along the lines of inoculation which had ramose edges and a wavy interlaced center. Incubation was at room tempera-

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[2] A contribution from The Phelps Laboratory, College of Engineering, University of Florida.

ture. No marked cultural differences were exhibited by any of the strains of *Sphaerotilus* tested on this medium.

A synthetic sewage medium (S medium) developed previously (Lackey and Wattie, 1940) was next used to study the growth of *Sphaerotilus* in a liquid substrate. The medium is composed essentially of minerals plus peptone and dextrose. The organisms were inoculated into 100 ml portions and incubated in duplicate, at room temperature in a dark room and also in a room especially equipped with lights for the cultivation of photosynthetic organisms. The growth obtained was typically white, fluffy cotton-ball like colonies dispersed throughout the medium but also dispersed as gelatinous strands. Growth changed from a fluffy cotton-ball type of colony to the gelatinous strand type after the first 24 hours of incubation; this illustrates the slimy consistency of the sheaths which, as growth increased, formed these masses of stranded material. It was also noted that a number of samples contained atypical cloudy growths; transfer of these organisms to a sewage agar medium (which has proved to be the best solid medium for maintenance of pure cultures) indicated that in practically all these cases the cultures were indeed *Sphaerotilus*. An interesting aspect of these atypical growths was that in every case the organism exhibited poor, slow growth upon transfer to sewage agar. This phenomenon indicates a variability in the cultural characteristics of the organism and that an identification on the basis of growth in one medium only would be insufficient. Positive identification can only be ascertained by a microscopic examination in conjunction with growth characteristics in several media. This variability is further exhibited in the cultural characteristics of the organism when grown on peptone agar. On this medium the colonies appear rough and have irregular undulating edges. No curled outgrowths are seen about the periphery of these colonies in contrast to the appearance in sewage agar. Again, there were no marked cultural differences between the various strains of *Sphaerotilus* in S medium nor did the absence or presence of light affect its growth. Growth in this liquid medium was generally poor. After 24 hours of incubation, growth was scant in all cultures.

Due to the poor growth obtained in S medium, it was decided to test the action of amino acids on *Sphaerotilus*. Since *Sphaerotilus* is commonly found in a habitat conducive to the growth of some other filamentous type organisms, such as the sulfur bacteria *Beggiatoa* and *Thiothrix,* normally found in sulfur waters, it seemed that the sulfur containing amino acids, d-l methionine and cystine, would be used. Studies with cystine were difficult due to its low solubility; as a result d-l methionine was used. The original S medium was modified by substituting magnesium acetate for the magnesium sulfate originally present in the medium and by varying the amount of d-l methionine between 10 and 200 ppm. The organism was inoculated into 100 ml portions of modified S medium and incubated in duplicate at room temperature. The rate of growth of *Sphaerotilus* was spectacularly accelerated by the addition of d-l methionine. Excellent growths were recorded at the end of 48 hours incubation and growth was approximately twice as dense at the end of 24 hours incubation than that in regular S medium. There was no further effect when the concentration of d-l methionine was increased beyond 10 ppm. It was further found that the organism could withstand massive concentrations of methionine without any injurious effects upon its growth rate.

It was found that the iron concentration in the medium was a critical factor in the amount of growth obtained. With a concentration of 25 mgms/liter of ferric chloride, growth was apparent but scanty. Reduction of ferric chloride to 2 mgms/liter resulted in increased growth of the organism. Since *Sphaerotilus* has been known for years as an iron bacterium due to its ability to deposit iron in the form of iron oxide along its sheath wall it was deemed significant that in this case growth seemed to be inhibited by the presence of iron. Modified S medium was prepared without any source of iron present other than that contained in plain Bacto peptone (.0033%); using .1 gm of peptone/liter and 10 ppm methionine the test was repeated. Growths obtained were excellent and of the same magnitude as when 2 mgms/liter of ferric chloride were used in the medium. This would tend to question the belief that iron is an essential ingredient for the cultivation of *Sphaerotilus*; at best it can only be inferred that trace amounts of iron may be necessary as is true for many organisms. The same reactions took place in this series of experiments as in that with regular S medium. At the end of 24 hours incubation colonies exhibited a white fluffy cotton-ball type growth. At the end of 48 hours incubation, growth was characterized by gelatinous strands of material once again, however, this time the medium had a strong distinctive amine odor, indicating utilization of methionine by the organism. This utilization probably takes place in the form of a decarboxylation or reduction of the amino acid resulting in the formation of an amine. Again no cultural differences were noted between the various strains of *Sphaerotilus* in modified S medium.

It has been shown that some bacteria require the presence of a number of recognized growth factors and that biotin in particular might be of widespread importance in microbial nutrition. With this in mind, the effect of vitamin B-12 was tested in modified S medium containing 10 ppm d-l methionine; and 0, ½, 1, 2, and 4 ppb vitamin B-12. These media were inculated with the fifteen pure strains of *Sphaerotilus* and incubated at room temperature. Growths obtained were typical of that obtained in modified S medium previously. There was no apparent effect on the growth or cultural characteristics by varying the concentration of vitamin B-12 in the ranges of 0 to 4 ppb. This indicates that either this organism does not require this particular growth factor or that it may be capable of synthesizing it.

The effect of copper sulfate on the growth of *Sphaerotilus* in modified S medium was next tested by adding various concentrations of $CuSO_4$ to the medium inoculated with pure strains of *Sphaerotilus*. As is true for many organisms a concentration of 1 ppm $CuSO_4$ completely inhibited growth. This could be pertinent for those interested in controlling the growth of *Sphaerotilus* in streams.

Pure strains were also tested in six liter portions of S medium an L medium under aeration and without aeration. Growth at the end of 24 hours incubation was good and characterized once again by white, fluffy colonies of dense growth. There was no apparent difference in those cultures with or without aeration. The addition of 10 ppm d-l methionine to the medium produced an increased growth of the same characteristics at the end of 24 hours incubation.

The effect of adding sodium thiosulfate to S medium under aeration was next tested. The pH of the medium was adjusted to 6.8 and concentrations as high as 1000 ppm of sodium thiosulfate still produced excellent growths. This fact clearly illustrated a high tolerance for sulfur by the organism under investigation.

The procedure of Skerman, Carey and Dementjeva (1957) was followed to test the ability of *Sphaerotilus natans* to oxidize hydrogen sulfide. The organism was cultivated in stoppered bottles containing ca 30 ml of .1% peptone in water at a pH of 7.0 with an air space of ca 250 cc between the liquid surface and the stopper. The stoppers were provided with two clamped outlets to allow gas to be introduced and replace the air. The medium was inoculated with pure strains of *Sphaerotilus* and incubated in the bottles until a fair growth resulted. The cultures were then exposed to hydrogen sulfide by replacing the 250 cc air space with hydrogen sulfide from a cylinder. They were then incubated and examined at the end of 24 and 48 hours. Growth was excellent and markedly enhanced. Microscopic examination of *Sphaerotilus* thus exposed to hydrogen sulfide revealed apparent intracellular deposits of sulfur in the form of dark globules. A portion of the culture was removed and put through repeated washings in distilled water. After washing, all evidence of sulfur external to the cells had disappeared, but the intracellular sulfur was still apparent. The filaments were then mounted in water under a coverslip and pyridine introduced by placing a drop at one edge of the coverslip and drawing it through by filter paper on the other side. The globules of sulfur were seen to disappear and leave a vacuole behind when the pyridine came in contact with the organism. Also upon application of carbon disulfide the globules were seen to dissolve and then crystalize in characteristic forms of sulfur upon evaporation. This apparent oxidation of hydrogen sulfide by the organism is rather significant and strengthens the hypothesis that perhaps we are actually dealing with a sulfur bacterium rather than an iron bacterium.

The effect of sulfur dioxide was also tested under the same conditions. The organisms did show an intracellular deposition of sulfur, however, none were viable after exposure. Obviously, the tolerance of *Sphaerotilus* to sulfur dioxide is not as great as to hydrogen sulfide. Further work is under-way to ascertain the exact SO_2 tolerance level of the organism.

In review the following conclusions have been reached.

First, despite dissimilar origins, all *Sphaerotilus* strains have behaved alike in culture.

Second, the presence of a sulfur containing amino acid or an HS group, greatly enhances growth of the organism.

Third, iron is only required in trace quantities to support growth of the organism. It is believed that the deposition of iron in the form of iron oxide along the sheath wall of the organism may be considered a characteristic of the group.

Finally, the organisms in these studies exhibited growth characteristics which would more accurately classify them as sulfur bacteria rather than iron bacteria.

LITERATURE CITED

BERGEY, D. H.
1957. Manual of Determinative Bacteriology. 7th Ed. Williams & Wilkins, Baltimore.

HOYLE, W. H.
1927. Part of a discussion on the operation of activated sludge plants, by H. T. Calvert. Proc. Assoc. Mgrs. Sewage Disposal Works.

LACKEY, J. B.
1945. A Report on the Biological Aspects of Paper Mill Pollution in Certain Parts of the Columbia River Watershed, with Especial Reference to *Sphaerotilus natans*. Mimeographed and privately circulated by The Stream Pollution Investigations Station, U.S.P.H.S., Cincinnati, Ohio.

LACKEY, J. B., and WATTIE, E.
1940. Studies of Sewage Purification XIII the Biology of *Sphaerotilus natans* Kützing in Relation to Bulking of Activated Sludge. Pub. Health Rep. 55: 22 (Reprint No. 2166).

SKERMAN, V. B. D., DEMENTJEVA, G., and CAREY, B. J.
1957. Intracellular Deposition of Sulfur by *Sphaerotilus natans*. Jour. Bact. 73: 4.

STOKES, J. L.
1954. Studies on the Filamentous Sheathed Iron Bacterium *Sphaerotilus natans*. Jour. Bact. 67: 3.

Quart. Journ. Fla. Acad. Sci. (1958), 21(4), 1959.

STUDIES ON WATER RELATIONS IN FLORIDA TERMITES
I. SURVIVAL TIME AND RATE OF WATER LOSS DURING DRYING

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Introduction

Species differences in tolerance of drying have been established in four members of the genus *Reticulitermes* (Williams, 1934, and Strickland, 1950). Caste differences in rate of loss and survival time during drying have been described in *Reticulitermes flavipes* (Kollar) by Dunmore and Collins (1951). In an attempt to determine the factors influencing rate of loss and survival time during desiccation, studies of water relations in termites were extended to include 9 of the 13 species of termites found in Florida.

Material

The termite fauna of Florida includes species distributed among the three major habitat types, subterranean, damp-wood, and dry-wood. The following listed species, with ranges and environmental moisture requirements as described by Miller (1949), were utilized in the study:

1. *Kalotermes jouteli* Banks, a large dry-wood termite limited largely to coastal zones of southern Florida, requiring more moisture than other species of the genus.
2. *Kalotermes schwarzi* Banks, similar to *K. jouteli,* but with a wider range.
3. *Kalotermes snyderi* Light, a species ranging inland and through north Florida, with a smaller moisture requirement than either *jouteli* or *schwarzi.*
4. *Cryptotermes cavifrons* Banks, a small dry-wood termite probably indigenous to Florida.
5. *Cryptotermes brevis* (Walker), seemingly an introduced species living in furniture and houses, and not yet reported from natural habitats.

6. *Neotermes castaneus* (Burmeister), the largest termite found in Florida, limited to damp wood or dead branches on living trees, ranging southward from Vero Beach.
7. *Reticulitermes hageni* Banks, the smallest species of the subterranean termites.
8. *Reticulitermes virginicus* Banks, an intermediate-sized species.
9. *Reticulitermes flavipes* (Kollar), the largest and most widely distributed species of the genus.

Field observations and reports from exterminating companies suggest that of the three species of subterranean termites, *R. hageni* has the lowest moisture requirement, *R. virginicus* is intermediate, and *R. flavipes* has the highest (Miller, 1949). All three *Reticulitermes* species are dependent upon a constant moisture supply, however, and this is usually obtained through soil contact. Unlike *Neotermes* and the dry-wood termites, *Reticulitermes* species do not form faecal pellets, but void a liquid excrement that is utilized in construction of galleries or ingested by other members of the colony. Desiccating specimens may occasionally show a plug of dry material protruding from the anus, but under culture in the laboratory or in the field, such pellets are not observed. In the dry-wood and damp-wood termites, water is extracted from the digestive wastes and a dry firm pellet is voided.

METHODS

Termites were collected in the Everglades National Park, the Florida Keys, the University of Miami South Campus, the greater Miami area, the Highlands Hammock State Park, and the Tallahassee area.

Maintenance of colonies of species with a high moisture requirement was achieved by placing the termites in finger bowls containing a ½ inch layer of a stiff solution of agar and sawdust.

Wood containing colonies of dry-wood termites was broken into small sections and placed in dressing jars. Lumps of agar-sawdust mixture were added when the termites showed signs of becoming desiccated.

Furniture termites were left undisturbed until needed. After colonies had been entered and experimental animals removed, some of the wood and the remaining termites were transferred to dressing jars. Agar-sawdust lumps were quickly utilized by *C. brevis* in forming enclosed cells between adjacent pieces of wood.

Ant attacks were prevented by surrounding the dressing jars with water or coating them with vaseline.

Rate of water loss of living specimens was determined by weighing groups of termites, exposing them to air of 0-4 per cent relative humidity for measured intervals of time, and determining the weight after exposure. The hourly rate of loss of individuals was computed by dividing the total weight lost by the group by the number in the group and the hours of exposure. Rate determinations were calculated on the basis of loss of body weight at the fourth hour of drying. No corrections were attempted for weight changes due to gain of O_2 or loss of CO_2. Gunn (1934) found that weight changes due to respiratory exchange had an upper limit of 10 per cent of the total loss in the cockroach, and stated that the rate of total loss could be taken as a satisfactory measure of the rate of water loss.

Weight determinations were made with a Becker Chain-O-Matic balance of 1/20 mg. sensitivity.

Indicating Drierite (anhydrous calcium sulphate with cobalt chloride) was the desiccant employed.

Four samples were run concurrently in most experiments. The number of termites used in a sample varied with size, species, and the number available.

Care was exercised to avoid jolting the weighing bottles containing the termites as far as was possible, as members of some species will evacuate the gut at a disturbance. It is probable that this source of error is partly involved in the variability between samples. It can be excluded by killing the termites before desiccating them.

Death could not be determined precisely, so an end point was chosen. Absence of observable movement after slight displacement was taken to indicate death.

OBSERVATIONS AND RESULTS

The results are summarized in Tables I, II, III, IV, V, and VI, and Figure I.

TABLE I

CASTES, SAMPLE SIZE AND NUMBER, WEIGHT, RATE OF LOSS, AND SURVIVAL RANGES

Species, Castes	No. of Samples	No./ Sample	Range, Sample Wgts, (Mg)	Range, Individual Wgts. (Mg)	Range, Rate of Loss Mg/Termite/Hr First Four Hours	Range, Av. Survival Time (Min. or days)
R. hageni — W., S.	5	25	26.0– 31.0	1.04– 1.24	.133–.174	240–297 Min.
R. virginicus — W., S.	4	30	74.2– 78.5	2.47– 2.70	.161–.217	360–376 min.
— Im. nymphs	1	25	73.7	2.94	.192	374 min.
— Im. nymphs	2	20	47.6– 48.5	2.38– 2.42	.102–.150	342–390 min.
— Im. 1-2 days	1	20	46.5	2.32	.235	288 min.
— Im. Old	1	20	40.0	2.00	.172	258 min.
R. flavipes — W.	1	20	58.5	2.92	.287	336 min.
— W., S.	7	25	63.5– 72.5	2.54– 2.90	.214–.302	259–374 min.
— Dry Agar, W., S.	1	25	72.0	2.88	.307	182 min.
— N., W., S., Sec. Sex.	1	25	73.4	2.93	.167	Not observed
— N., W., S.	2	20	63.2– 68.0	3.16– 3.40	.200–.265	Not observed
— Im, 1–3	1	20	89.1	4.45	.290	354 min.
C. cavifrons — Wet N	2	22	71.2– 71.3	3.23– 3.24	.036–.042	No deaths
— Wet N	1	10	39.6	3.96	.04	————
— Dry N	3	20	53.7– 80.5	2.68– 4.02	.009–.022	————

Table I (Continued)

C. brevis	— N	5	10	58.0– 85.4	5.80– 8.54	.000–.050	1 death, probably injured
	— N	1	15	91.8	6.12	.003	
	— Im.	1	15	61.0	4.06	.015	————
K. snyderi	— N., S.	2	8	67.2– 85.0	8.4 –10.6	.041–.062	< ½ dead: 22 days
	— N	1	8	73.0	9.1	.062	
	— N	4	10	78.7–105.7	7.87–10.57	.020–.097	
K. schwarzi	— N	4	10	88.8–119.5	8.88–11.95	.045–.090	11.6 days
K. jouteli	— Wet N	5	10	80.7–110.4	8.07–11.04	.09 –.19	4+ days
	— Dry N	3	10	149.5–222.2	14.95–22.21	.052–.090	12+ days
	— Dry N	2	4	55.0– 83.0	13.75–20.7	.056–.093	
	— Dry Im.	2	4	61.6– 70.5	15.4 –17.6	.156–.162	
N. castaneus	— 1st run N	6	10	95.5–150.2	9.55–15.02	.210–.367	3+ days
	— 2nd run N	2	10	92.3– 95.7	9.23– 9.57	.182 (both groups)	

W = Workers
Im. = Imagoes
N. = Nymphs
S. = Soldiers
Sec. Sex. = Secondary Reproductives

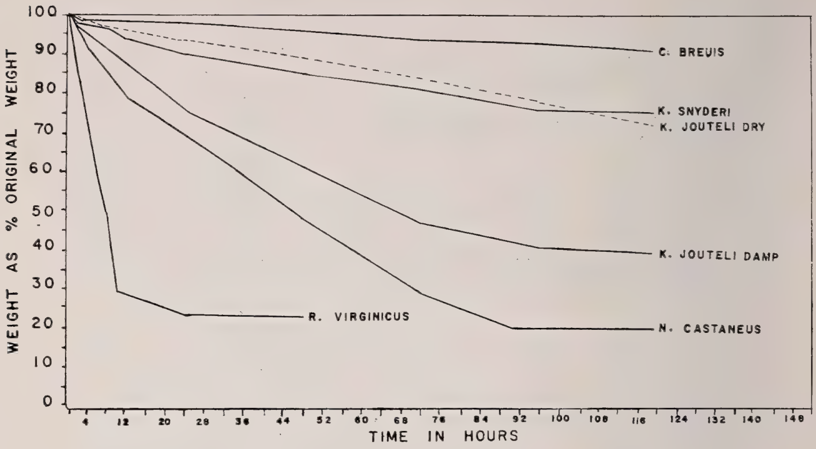

Figure 1. Percentage of body weight remaining at intervals during desiccation (2-120 hours).

Rate of loss decreased with time in species except *Cryptotermes* (*brevis* and *cavifrons* cultured dry), where the initial rate was low and remained low unless a member of the group showed signs of injury. The rate decrease was pronounced in dry-wood termites cultured under moist conditions.

TABLE II

RATE OF LOSS EXPRESSED AS MG/TERMITE/HOUR
DATA ON W, S, N GROUPS—FIRST FOUR HOURS OF DRYING

Species	Average Rate of Loss ± S. E.	σ
Reticulitermes flavipes	.260 ± .013	.0460
Neotermes castaneus — 1st run	.251 ± .027	.0608
— 2nd run	.182	
Reticulitermes virginicus	.178 ± .019	.0480
Reticulitermes hageni	.155 ± .029	.0580
Kalotermes jouteli—wet	.149 ± .019	.0340
Kalotermes jouteli—dry	.070 ± .024	.0540
Kalotermes schwarzi	.066 ± .009	.0180
Kalotermes snyderi	.052 ± .010	.0230
Cryptotermes cavifrons—wet	.039 ± .002	.0030
Cryptotermes cavifrons—dry	.016 ± .004	.0069
Cryptotermes brevis	.015 ± .007	.0192

Imagoes were more active than nymphs dring desiccation, and subterranean termites were more active than the dry-wood or furniture termites. The latter groups tended to "huddle", and remain motionless until the desiccator was opened for observation.

TABLE III

STATISTICAL COMPARISONS BETWEEN SPECIES LISTED IN TABLE II (RATIO OF DIFFERENCE, D, TO THE STANDARD ERROR OF THE DIFFERENCE σD)

Species Compared	$D/\sigma D$	P
R. flavipes / R. virginicus	3.5	$< .003$
R. virginicus / R. hageni	$D<\sigma D$	
R. hageni / R. flavipes	3.2	$< .003$
R. flavipes / N. castaneus	$D<\sigma D$	
K. jouteli wet / K. jouteli dry	3.95	$< .003$
R. hageni / K. jouteli dry	2.83	$< .005$
R. hageni / K. jouteli wet	$D<\sigma D$	
C. cavifrons wet / C. cavifrons dry	9.2	$< .00001$
C. cavifrons dry / C. brevis	$D<\sigma D$	
C. brevis / K. snyderi	3.0	.003

Deaths in dry-wood termites (*Kalotermes* species) were widely separated. It appeared that an individual in the group would be drained of fluid, then another, and so on until only one or two were active. These would look normal long after the others had become much flattened.

Cryptotermes brevis nymphs did not appear to eat or drain the single specimen that died during the course of an experiment. Unlike other species of termites here, they do not seem to eat the exuviae cast during an experiment or in the culture containers. They will drink water if it is offered to them on pieces of paper towel or wood. It appears impracticable to attempt to desiccate them to death, as starvation would probably kill them before drying would.

TABLE IV

DECREASE IN RATE OF WATER LOSS WITH TIME

Rate as Mg/Termite/Hr.

			Init. Wgt.	Rate of Loss at Hour								
Species	Caste	N	(mg)	4	12	23	24	48	50	117	119	120
N. castaneus	Nymphs	10	9.55	.245	(allowed to drink; re-weighed, re-run)							
	2nd run	—	9.23	.182	—	.122	—	—	—	—	—	—
	Nymphs	10	9.88	.210	—	—	.141	—	—	—	—	—
	Nymphs	10	10.90	.192	—	—	.128	—	—	—	—	.068
	Nymphs	10	15.02	.367	.290	—	—	—	—	—	—	—
K. jouteli, Wet	Nymphs	10	9.56	.190	—	—	—	.036	—	—	—	.059
	Nymphs	10	10.9	.150	—	—	—	.083	—	—	—	.061
	Nymphs	10	11.04	.107	—	—	—	—	.098	—	—	.061
K. jouteli, Dry	Nymphs	10	14.95	.0675	—	—	.047	—	—	.032	—	—
	NJPM°	—	22.21	.052	(Metamorphosing)		.050	.045	—	—	—	.058
	(8 Imagoes by 144 hours)											
X. schwarzi	Nymphs	10	8.98	.072	—	—	—	.041	—	.032	—	—
	Nymphs	10	11.48	.040	—	—	—	.036	—	—	—	.028
K. snyderi	Nymphs	10	7.87	.045	—	—	—	.023	—	—	.015	—
	Nymphs	10	10.57	.097	—	—	—	.055	—	—	.032	—
C. brevis	Nymphs	10	8.54	No loss	—	—	.007	—	—	—	—	.006

° Nymphs just prior to metamorphosis.

TABLE V

AVERAGE SURVIVAL TIME IN MINUTES AND % BODY WEIGHT LOST AT INTERVALS TO CONSTANT WEIGHT (C. W.) W., S. GROUPS, SPECIES OF *RETICULITERMES*

Species	N	Average Survival Time in Minutes ± S. E.	σ	Av. Init. Wgt. (mg)	Rate of Loss Mg/T/Hr	% Body Weight Lost at			
						1st death	½ dead	All dead	C. W.
R. hageni	100	266 ± 7.88	78.8	1.12	.151	32.8	55.4	74.7	87.4
R. flavipes	175	326 ± 7.16	94.8	2.73	.259	28.8	47.5	61.2	83.9
R. virginicus	90	369 ± 8.82	84.2	2.53	.181	28.6	42.4	55.5	77.2

TABLE VI

STATISTICAL COMPARISONS, SURVIVAL TIMES FOR SPECIES LISTED IN TABLE V (RATIO OF DIFFERENCE, D TO THE STANDARD ERROR OF THE DIFFERENCE, σD)

Species Compared	$D/\sigma D$	P
R. hageni / *R. virginicus*	8.65	$< .001$
R. flavipes / *R. hageni*	5.33	$< .001$
R. virginicus / *R. flavipes*	2.59	.02–.01

DISCUSSION

Survival under desiccation appears to be conditioned by the rate of water loss, body size, and behavior during desiccation. Body size seems to have no relation to rate of loss, but large termites that lose water rapidly may survive desiccation longer than small termites that lose water less rapidly. Termites that remain quiet and grouped during desiccation lose less rapidly than those that are more active. Evacuating the gut upon disturbance, such as removal of the desiccator lid, is probably concerned in the variability in rate of loss in *Kalotermes, Neotermes,* and *Cryptotermes* species. *Reticulitermes* does not seem to give this response so readily.

It has been shown by Kühnelt, Wigglesworth, Ramsay and others that loss of water from the body surface of an insect is prevented or retarded by a layer of fats and waxes, the epicuticle. An additional "cement" layer has been demonstrated in some insects. The presence of protective layers on the termite integument, of differing effectiveness in retarding water loss at 34° C., is suggested by the differences in rate of loss between species, the reduction in rate of loss following exposure to dry air, and the marked differences in rate of loss following culture under very dry, as contrasted to damp, conditions.

It appears unlikely that *Cryptotermes* species and *Kalotermes snyderi* survive in their respective habitats by maintaining a moderate to high humidity within the galleries. Crucial evidence will involve rate of water loss of the eggs, which have not yet been available in sufficient quantity to determine rate of loss. However, it is probable that these species can subsist in dry surroundings on water released from oxidation of food, since the rate of water loss is normally very low and water can be extracted from the digestive wastes before these are voided. Limited observations indicate that a high environmental humidity is detrimental to *Cryptotermes brevis.*

Reticulitermes species require a rather high, constant environmental water supply. While water is not removed from the digestive wastes before voiding, the habits of proctodaeal feeding and using the faeces in constructing protective shelters ultimately result in water conservation. The frequently-observed cannibalistic behavior may also be involved.

Neotermes castaneus and *Kalotermes jouteli* from damp environments lose water rapidly at first, but as desiccation proceeds the rate drops to one near that of other *Kalotermes* species. The large size of both forms, along with the decrease in rate of loss with time, would facilitate survival during intermittent droughts.

Cryptotermes cavifrons, ordinarily an inhabitant of dry, sound wood, has been collected in wood so damp that free water could be forced from it with a knife blade. It will be of interest to determine whether *C. brevis* can survive under such conditions.

No evidence was obtained to substantiate Kofoid's suggestion that the winged forms could survive drying longer than members of the colony lacking the pigmented, rigid integument.

ACKNOWLEDGMENTS

The author wishes to express appreciation to her husband, Herbert L. Collins, for assistance in collecting specimens and for providing encouragement and time to perform experiments; to E. M. Miller, University of Miami, for specimens and valuable information about collecting in the Miami area; to the personnel of the Everglades National Park and the Highlands Hammock State Park for permitting colonies to be taken in those areas; and to the Florida A. and M. University for facilities utilized in the investigations. Identifications of species were made with the aid of specimens kindly provided by A. E. Emerson, and a doubtful identification was verified by Frank A. Banks, both of the University of Chicago. Assistance in establishing laboratory cultures of termites was rendered by Dorothy A. Brickler and Mack Gardner, Jr., who also assisted in preparation of the graph. Colonies of *Cryptotermes, Neotermes,* and alates of *R. virginicus* were provided by F. G. Butcher, University of Miami, Clifford and Iva McDuffy and the Orkin Exterminating Company of Tallahassee. The manuscript was read critically by several colleagues.

LITERATURE CITED

DUNMORE, L., and M. S. COLLINS

1951. Caste Differences in Toleration of Drying in *Reticulitermes flavipes* (Kollar). Anat. Rec. 111, No. 3, Nov. (Abstract, A. A. A. S. Report).

GUNN, D. L.

1935. The Temperature and Humidity Relations of the Cockroach, III. Jour. Exper. Biol., 12: 185-90.

KOFOID, C. A.

1934. Chapter 2 *in* Termites and Termite Control. University of California Press, Berkeley, California.

MILLER, E. M.

1949. A Handbook on Florida Termites—Technical Series, University of Miami Press.

RAMSAY, J. A.

1935. Evaporation from the Cockroach. J. Exper. Biol., 12: 373-83.

STRICKLAND, M. J.

1950. Differences in Toleration of Drying Between Species of Termites (Reticulitermes). Ecology, Vol. 31, No. 3: 373-385.

WIGGLESWORTH, V. B.

1948. The Insect Cuticle. Biol. Rev., Cambridge Philosoph. Soc., (23): 408-51.

WILLIAMS, O. L.

1934. Chap. 4 *in* Termites and Termite Control. University of California Press, Berkeley, California.

Quart. Journ. Fla. Acad. Sci. (1958), 21(4), 1959.

TWO NEW SPECIES OF *LYNGBYA* C.Ag.

Ronald C. Phillips
Florida State Board of Conservation Marine Laboratory[1]

Several months of investigation concerning epiphytic growth on the leaves of *Thalassia testudinum* K. & S. have produced some interesting results. This study was undertaken in two distinct types of marine habitats, one being in Boca Ciega Bay in Pinellas County, and the other at North Key in Pasco County, near Tarpon Springs, Florida.

The two species described below were discovered as a result of this study. The subgenus to which these plants belong contains relatively inconspicuous members. It is my opinion that species belonging to this group are ill-known owing to paucity of work attempted on marine algal epiphytes.

Taxonomy

Subgenus I. Leibleinia Gomont. Filaments caespitose, attached to submersed plants, attached at middle and entangled, then ascending on all sides. Sheaths thin, hyaline, never conspicuously lamellose. Trichomes not attenuate at apex. Plants marine.

Lyngbya thalassiae n. sp.

Type from northeast corner of North Key, Tarpon Springs. Type placed in herbarium of Dr. Francis Drouet.

> Caespituli fasciculati usque ad 2 mm. longi ad *Thalassiam testudinum* K. & S. affixi, filamentis elongatis rectis flexilibus, vaginis cylindricis hyalinis tenuibus usque ad 1-1.5μ crassis chlorozincico iodurato coerulescentibus, trichomatibus roseis cylindraceis ca. 11.5μ crassis ad genicula leviter constrictis ad apices non attenuatis, cellulis ad basem trichomatis praecipue quadratis 7-19μ longis, cellulis ad apicem trichomatis diametro ad duplo brevioribus 4.5-7μ longis, protoplasmate cellularum mediarum et apicalum tenui-granuloso, cellula apicali rotundata haud capitata, membrana superna non incrassata.

Tufts fasciculate, to 2 mm. tall, attached to *Thalassia testudinum* K. & S. Filaments elongate, straight, pliant. Sheaths thin, 1-1.5 μ thick, smooth, hyaline, turning blue with chlor-zinc-iodine. Trichomes pinkish-red, apices not attenuate, about 11.5 μ wide throughout; cells very slightly constricted at cross-walls, mostly quadrate at base, to ½ as long as wide at middle and apex of trichome, 7-19 μ long at base to 4.5-7 μ long at trichome middle and apex; no granules in cells at base, occasionally found in upper cells; cells cylindrical. Apical cell rotund, membrane not thickened, not capitate. Figs. 1-4.

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[1] Contribution No. 21 from the Florida State Board of Conservation Marine Laboratory, St. Petersburg, Florida.

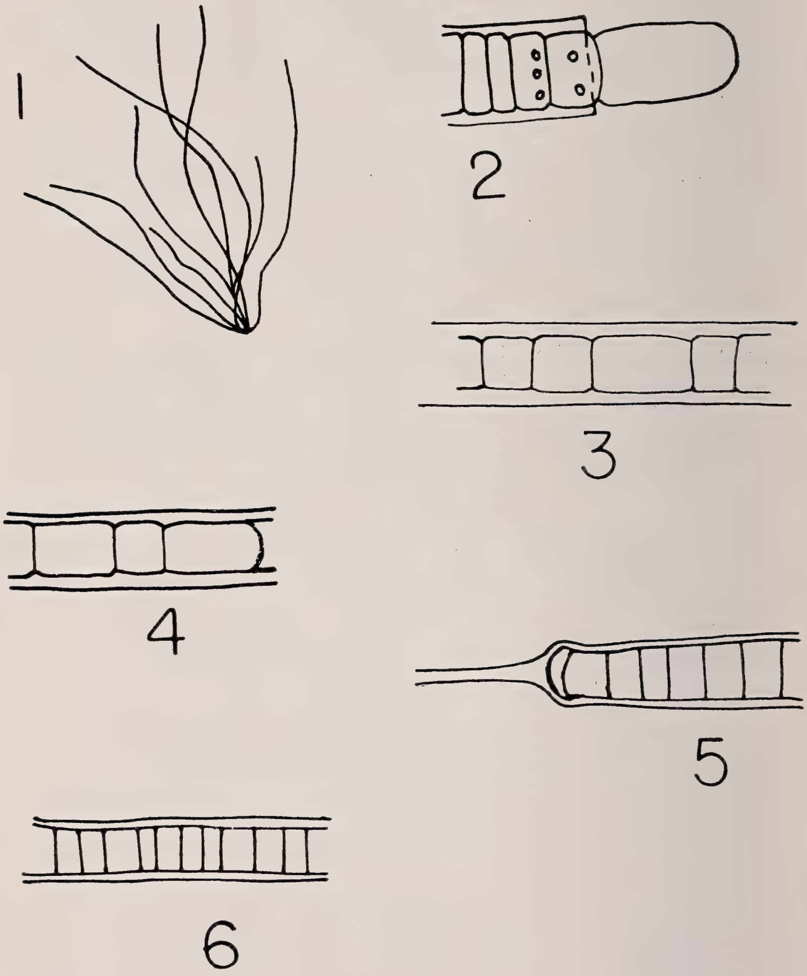

Figure 1. *Lyngbya thalassiae* n. sp. 1. habit, 22X; 2. apex of filament, 690X; 3. base of filament, 690X; 4. apex of young filament, 690X. *Lyngbya mittsii* n. sp. 5. apex, 430X; 6. intermediate portion of filament, 430X.

Lyngbya mittsii n. sp.

Type from Cats Point Bank, Boca Ciega Bay. Type placed in herbarium of Florida State Board of Conservation Marine Laboratory. Cotype placed in herbarium of Dr. Francis Drouet.

> Caespituli fasciculati usque ad 2 mm. longi ad *Thalassiam testudinum* K. & S. affixi, filamentis elongatis rectis flexilibus, vaginis cylindricis hyalinis tenuibus usque ad 1μ crassis chlorozincico iodurato non coerulescentibus, trichomatibus aerugineis cylindraceis 9-9.5μ crassis ad genicula non (in vivo) constrictis (in formalina plus minusve torulosis) ad apices non attenuatis, cellulis diametro ½-¾ brevioribus, protoplasmate haud granulosa, cellula apicali rotundata quasi-capitata, membrana superna conspicue incrassata.

Tufts fasciculate, to 2 mm. tall, attached to *Thalassia testudinum* K. & S. Filaments elongate, straight, pliant. Sheaths thin, no more than 1 μ wide, smooth, hyaline, not turning blue with chlor-zinc-iodine. Trichomes blue-green, apices not attenuate, 9-9.5 μ wide throughout; cells not constricted at cross-walls (some possessing torulose aspect owing to formalin preservative), cells ½-¾ as long as broad, not granular, cylindrical. Apical cell rotund, membrane conspicuously thickened, slightly capitate. Figs. 5-6.

The specific epithet *mittsii* is in honor of Mr. Ernest Mitts, Director of the Florida State Board of Conservation.

DISCUSSION

The hydrographic data for *Lyngbya thalassiae* is as follows: salinity—27.1 0/00; temperature—23.6° C.; depth of water—3 ft.; water—very clear; moon phase—FM; date—25 Nov. 1958; field collection number—RCP 229-58. The alga was attached very sparsely to the leaves of *Thalassia*. The type location is sheltered from strong tidal currents which prevail at Tarpon Springs, but the water is not stagnant. Water exchange and flow is constant, except for a short period of slack low tide, from the open Gulf of Mexico.

The species approaches most closely that of *Lyngbya baculum* Gom., but differs in these several points: the filaments of *L. thalassiae* are not rigid, the color is not aeruginous, the trichomes are not torulose but are merely very slightly constricted at the end of cells, the cells are longer than 3-7.5 μ at the trichome base, and the cells of *L. thalassiae* are quadrate to ½ as long as broad while those of *L. baculum* are subquadrate to ½ as long as wide.

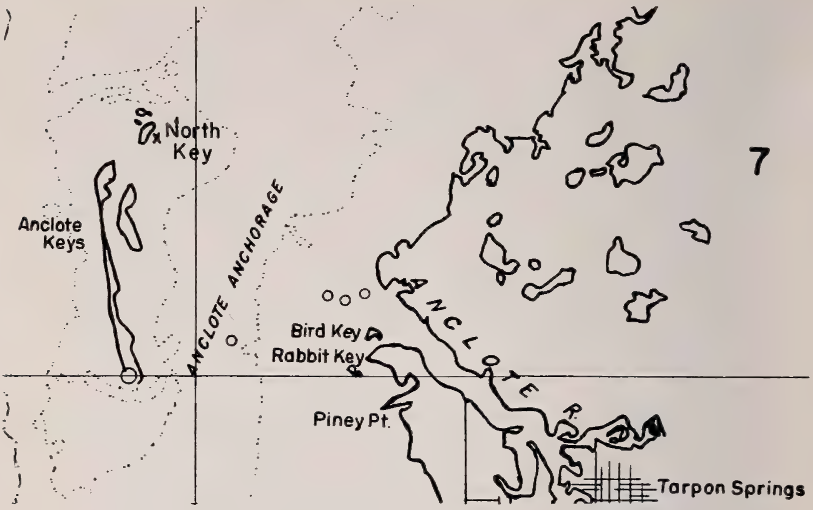

Figure 2. Location of collection of *Lyngbya thalassiae* n. sp.

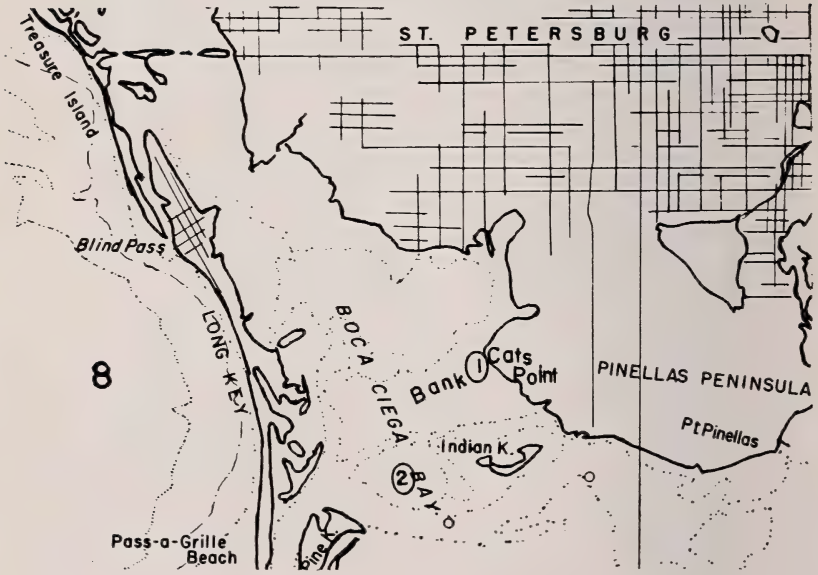

Figure 3. Location of collections of *Lyngbya mittsii* n. sp. 1. Type locality; 2. Bird Key Middle Ground collection.

The hydrographic data for *Lyngbya mittsii* is: salinity—31.7 0/00; temperature—20.0° C.; depth of water—12 inches; water—extremely turbid; moon phase—NM; date—10 Dec. 1958; field collection number—RCP 235-58. The alga was attached abundantly to the *Thalassia* leaves. Cats Point Bank is characterized by a soft muddy sand bottom, and the water is usually extremely turbid. At times the bottom is not visible in 9 inches of water. The water is of fairly high salinity, but surface runoff from shore through mangroves tends to produce a slight amount of pollution. At slack low tide a condition of water stagnation obtains. Nevertheless, Cats Point Bank supports dense growths of *Thalassia* and *Diplanthera.*

The ultimate fate of Cats Point Bank is not certain at this time. Dredge and fill activities are scheduled for this area, and to date a small artificial island has been raised at the southern limit of the Bank, but whether the type locality will be eradicated is only speculation.

Lyngbya mittsii was also collected on the same day on *Thalassia* leaves on Bird Key Middle Ground. This portion of Boca Ciega Bay has similar salinities and has identical temperatures and water depth but is in the middle of the bay away from any surface runoff from shore and never was observed with any condition of stagnation. Tidal exchange is thorough in this more exposed bay location. Field collection number for this collection was RCP 236-58.

Lyngbya mittsii was very abundantly collected on surface utricles of *Codium isthmocladum* Vickers in 40 feet of water, 240° off Johns Pass, 11 miles out in the Gulf of Mexico on 7 Dec. 1958. The alga displayed two colors in this depth, the one typical of the type collection from Cats Point Bank, and the other was red. This red color is considered to be a normal phenomenon for blue-green algae found at this depth. Many Lyngbyas have been observed in other collections in deep water, and their color has always been red. The observation that the sheaths of the filaments found in 40 feet of water did turn blue with application of chlor-zinc-iodine is very significant. Those of the type on Cats Point Bank did not turn blue. It suffices here to state that to the present this chemical reaction as applied to the sheaths of many of the Oscillatoriaceae has been considered a vital taxonomic character. The field collection number for this deep water collection was RCP 245-58.

I wish to express sincere appreciation to Messrs. K. D. Woodburn and A. B. Mann for their aid in obtaining the Tarpon Springs collection, and to Drs. V. G. Springer, R. T. Kirk, and P. M. McGarry and Mr. B. Brackin for the collection in the Gulf of Mexico. Special acknowledgment is accorded to Dr. Francis Drouet, New Mexico Highlands University, for drafting the Latin descriptions of the new species and for other considerations extended during this study. Dr. R. F. Hutton has been most helpful in his criticisms of the manuscript for which the author has been most appreciative.

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CONTENTS OF VOLUME 22

Number 1

A Study of *in vitro* Ovulation in the Eastern Spadefoot Toad, *Scaphiopus h. holbrooki. By Keith L. Hansen* 1

A Checklist of the Stomatopod Crustaceans of the Florida-Gulf of Mexico Area. *By Raymond B. Manning* 14

Extrusive Incisor Growth in the Rodent Genera *Geomys, Peromyscus,* and *Sigmodon. By Arthur J. Manaro* 25

A Comparison of *Trachinotus cayennensis* with *T. carolinus* and *T. paitensis. By Hugh M. Fields* 32

Academic Success in College: I. High School Preparation. *By Stan E. Wimberly* 41

A Pleistocene *Terrapene* Hibernaculum, with Remarks on a Second Complete Box Turtle Skull from Florida. *By Walter Auffenberg* 49

Comparison of the Teratogenic Effects of Trypan Blue and Low Temperature in the Medaka Fish (*Oryzias latipes*). *By John C. Briggs and James G. Wilson* 54

Observations on Tropical Marine Fishes from the Northeastern Gulf of Mexico. *By David K. Caldwell* 69

Notes on *Trachypeneus* (*Trachysalambria*) *similis* (Smith), in the Tortugas Shrimp Fishery. *By Bonnie Eldred* 75

Canine Teeth in Florida White-Tailed Deer (*Odocoileus virginianus seminolus* Goldman and Kellogg). *By Charles M. Loveless and Richard F. Harlow* 76

Number 2

The Dynamics of City Development. *By Richard K. Morton* 81

Effects of Burning on Vegetation and Rodent Populations in a Longleaf Pine Turkey Oak Association in North Central Florida. *By Andrew A. Arata* 94

Northern Extensions in the Recorded Ranges of Plants on Seahorse and Associated Keys, Levy County, Florida. *By Albert M. Laessle and Charles H. Wharton* 105

Two New Eyeless Ostracods of the Genus Entocythere from Florida. *By Margaret Walton and Horton H. Hobbs, Jr.* 114

Protozoan Fauna of a Limestone Sinkhole in North-Central Florida. *By Douglas A. Rossman* 121

Four Trematodes from the Black Skimmer, *Rynchops nigra* Linn., (Aves: Rynchopidae), in Gasparilla Sound, Florida, Including the Description of a New Genus and Two New Species. *By Franklin Sogandares-Bernal* 125

Revaluation of the Pleistocene *Urocyon seminolensis* from Florida. *By Andrew A. Arata* 133

Number 3

Two Exploratory Studies on Inter-Faith Dating. *By Earle E. Emme* 137

President's Report. *By E. Ruffin Jones* 146

Soil Fungi from Chrysanthemum Plantings. *By Curtis R. Jackson* 147

Notes on the Marine Flora of the Marquesas Keys, Florida. *By Ronald C. Phillips* 155

The Benthic Algae of Bahia Fosforescente, Puerto Rico. *By Luis R. Almodovar and Hugo L. Blomquist* 163

Number 4

Development and Evolution of Skeletal Deletions in a Family of Viviparous Fishes (Cyprinodontiformes, Poeciliidae). *By Donn E. Rosen and Klaus D. Kallman* 169

Sir Thomas Browne (1605-1682), Debunker of Popular Superstitions. *By Evelyn Allen Hammett* 191

Radioactive Monitoring and Environmental Health. *By George B. Morgan and F. Wellington Gilcreas* 197

Herpetofaunal Survey of the Pine Hills Area of Southern Illinois. *By Douglas A. Rossman* 207

Macrocallista nimbosa at Alligator Harbor. *By R. M. Akin and H. J. Humm* 226

Florida Academy of Sciences—Council—Editor—Sectional and Committee Chairman 229

Membership, Florida Academy of Sciences, March 29, 1960 230

63

Quarterly Journal
# of the
Florida Academy
# of Sciences

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Vol. 22 **March, 1959** **No. 1**

Contents

Hansen—A Study of *in vitro* Ovulation in the Eastern Spadefoot Toad, *Scaphiopus h. holbrooki* 1
Manning—A Checklist of the Stomatopod Crustaceans of the Florida - Gulf of Mexico Area 14
Manaro—Extrusive Incisor Growth in the Rodent Genera *Geomys, Peromyscus,* and *Sigmodon* 25
Fields—A Comparison of *Trachinotus cayennensis* with *T. carolinus* and *T. paitensis* 32
Wimberly—Academic Success in College: I. High School Preparation 41
Auffenberg—A Pleistocene *Terrapene* Hibernaculum, with Remarks on a Second Complete Box Turtle Skull from Florida 49
Briggs and Wilson—Comparison of the Teratogenic Effects of Trypan Blue and Low Temperature in the Medaka Fish *(Oryzias latipes)* 54
Caldwell—Observations on Tropical Marine Fishes from the Northeastern Gulf of Mexico 69

RESEARCH NOTES

Eldred—Notes on *Trachypeneus (Trachysalambria) similis* (Smith), in the Tortugas Shrimp Fishery 75
Loveless and Harlow—Canine Teeth in Florida White-Tailed Deer *(Odocoileus virginianus seminolus* Goldman and Kellogg) 76

Vol. 22 March, 1959 No. 1

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A STUDY OF *IN VITRO* OVULATION IN THE EASTERN SPADEFOOT TOAD, *SCAPHIOPUS H. HOLBROOKI*[1]

Keith L. Hansen
Stetson University

The first experiments concerned with the induction of ovulation by implantation of pituitary glands were performed on mammals (Ascheim, 1926; Smith, 1926; Zondek, 1926). Since that date many workers have demonstrated that pituitary materials will induce ovulation in representatives from most of the vertebrate classes. Rugh (1935), showed that excised ovaries from *Rana pipiens* would ovulate in Ringer's solution when their donors were injected with pituitary materials some hours before the removal of the ovary. The first experiments exclusively employing *in vitro* ovulation were conducted by Heilbrunn *et al.* (1939), in which whole untreated ovaries from *R. pipiens* were suspended in Ringer's solution containing macerated pituitaries. Ovulation ensued and all the eggs which ovulated showed first polar-body formation. Ryan and Grant (1940) helped to establish the normalcy of *in vitro* ovulation by artificially fertilizing eggs which had been ovulated by this technique and placed in the coelomic cavity of an ovariectomized female, where they passed through the oviducts receiving a jelly coat. Such eggs cleaved normally and most hatched into swimming tadpoles. In 1945, Wright described some of the quantitative and biochemical aspects of *in vitro* ovulation in *R. pipiens*. Wright and Hisaw (1946) showed that mammalian pituitary extracts evoked ovulation, both *in vitro* and *in vivo* in the leopard frog. Wright (1946) reported that hypophysectomy

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[1] This report is a portion of a dissertation presented to the University of Florida in partial fulfillment of the requirements for the Doctor of Philosophy degree.

SMITHSONIAN INSTITUTION SEP 2 1959

brought about an increased responsiveness of the ovary to *in vitro* ovulation, this probably being caused by the release of gonadotropins in the operation. This hypothesis was strengthened by the increase in ovulation *in vitro* following the immersion of ovarian pieces in serum taken from hypophysectomized frogs (Wright and Macintyre, 1950). Rondell (1953) used the *in vitro* ovulation technique to study the metabolic systems operative in ovulation in *R. pipiens* but was unable to show the precise method of operation.

Although the writer's primary interest has been a general study of the physiological and ecological factors involved in the breeding response of the eastern spadefoot, the present discussion will be confined to a number of factors affecting ovulation *in vitro.*

Materials and Methods

Over 1000 spadefoot toads, *Scaphiopus h. holbrooki,* collected from a single area near Gainesville, Florida, were used in this study. In general, the *in vitro* technique used was similar to that described by Wright (1945). Ovarian donors weighed from 10 to 20 grams and had head widths varying from 18 to 23 mm. The ovaries were removed and cut into small pieces containing 20 to 35 eggs each. These fragments were suspended by cotton threads in stoppered vials containing 10 ml. of Holtfreter's solution (Fig. 1). Ovulation was induced by the addition of spadefoot pituitary homogenate.

The extripation of the pituitary involved severing the cranium from the body, removing the oral mucosa, inserting fine-pointed scissors lateral to the medulla and cutting out the ventral portion of the brain case. The exposed pituitary lies just posterior to the optic chiasma. The round glandular anterior lobe is easily removed from the intermediate and posterior lobes with fine-pointed forceps. Pituitaries were macerated with a small mortar and pestle and diluted with an appropriate amount of Holtfreter's solution.

Ovulation was never observed in blank controls of Holtfreter's solution used in each experiment to check for possible spontaneous ovulation. All tests were allowed to stand for 18 hours and were conducted at a room temperature of approximately 23°C., unless otherwise indicated.

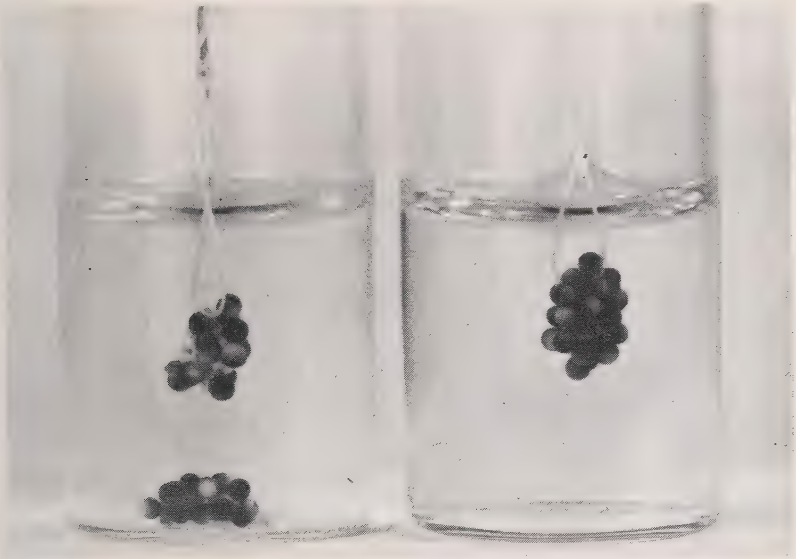

Figure 1. Control vial (right) with ovarian fragment suspended in Holtfreter's solution and experimental vial (left) containing pituitary homogenate showing fallen eggs which have been ovulated.

Percentages of ovulation were determined by dividing the number of eggs ovulated (*i.e.,* falling to the bottom of the vial) by the total number of eggs present in the ovarian fragment, and multiplying by 100.

Results

Nine factors affecting *in vitro* ovulation in the eastern spadefoot were considered.

1. *Comparative Potency of Male and Female Pituitary.*—Since approximately 50% of the individuals collected were males which could be utilized as an additional pituitary source, a test was designed to compare the relative potency of male and female glands. Pituitaries from five male toads proved to be 81% as potent as that from five equal-sized females. Equivalent weights of dried pituitary showed the male 76% as effective as the female in eliciting ovulation.

2. *Individual Variation.*—Both Wright (1945) and Rondell (1953) using *R. pipiens* found considerable variation in ovulation

percentages. To test the variation between individuals, eight pieces of ovary from six equal-sized females were exposed to a standardized pituitary solution. A statistical comparison between ovulation means showed no significant differences. In subsequent experiments, statistical comparisons showing significant differences were considered valid.

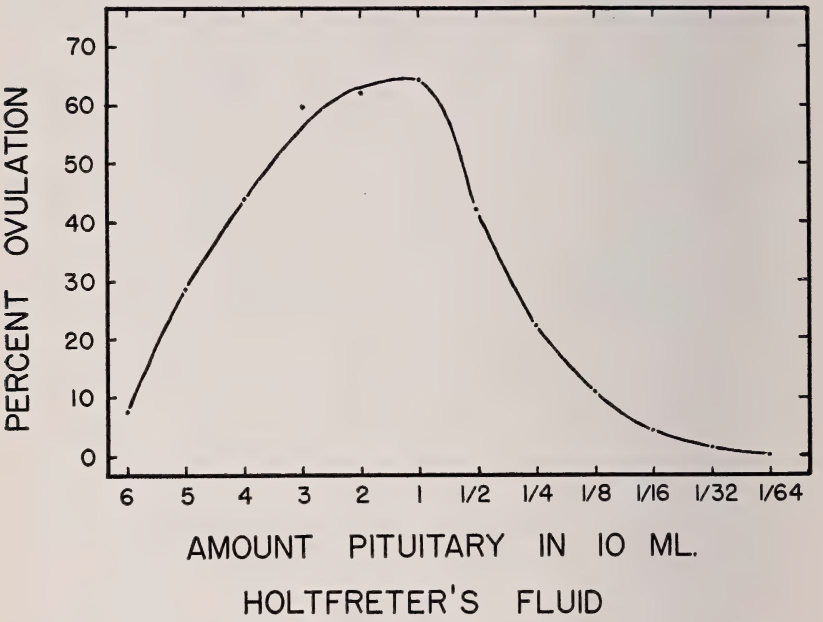

Figure 2. *In vitro* ovulation results obtained from varied concentrations of pituitary suspensions. Each point on the graph represents the average percentage of ovulation obtained in six vials.

3. *Relation of Toad Size.*—Eggs from a single individual were distributed among a 42 vial series, employing pituitaries from males ranging in head width from 17 to 23 mm. The mean percentage of ovulation for each size class was as follows: 17mm.—29%; 18 mm.—37%; 19 mm.—36%; 20 mm.—29%; 21 mm.—32%; 22 mm.—37%; 23 mm.—36%. The correlation between the size of pituitary donors and percentage of ovulation was low (r= +0.11) and lacked statistical significance due to the small sample. Utilizing the ovulation data from all experiments in which females were not subjected to experimental conditions (350 individual tests),

a low negative correlation (r= —0.16) was found; this test proved to be highly significant (P.< 0.01). From these data it appears that the size of the pituitary donor has little influence upon the inducement of ovulation.

4. *Effect of Pituitary Dilution.*—In order to establish the optimal amount of pituitary material needed to produce maximal ovulation, a series of pituitary dilutions ranging from 6 glands to 1/64 of a gland in 10 ml. of Holtfreter's solution was effected. The ovulation percentages (Fig. 2) for the various pituitary dilutions were as follows: 6 glands—7.5%; 5—28.5%; 4—44.4%; 3—59.5%; 2—61.8%; 1—64.5%; 1/2—42.1%; 1/4—22.5%; 1/8—11.1%; 1/16—4.3%; 1/32—1.4%; and 1/64—0.0%. Ovulation was found to be inhibited by both high and low concentrations of pituitary homogenate and maximal results occurred with one pituitary in 10 ml. of fluid. These results are in accord with Wright (1945) who found inhibition of ovulation with *R. pipiens* when using high concentrations of pituitary.

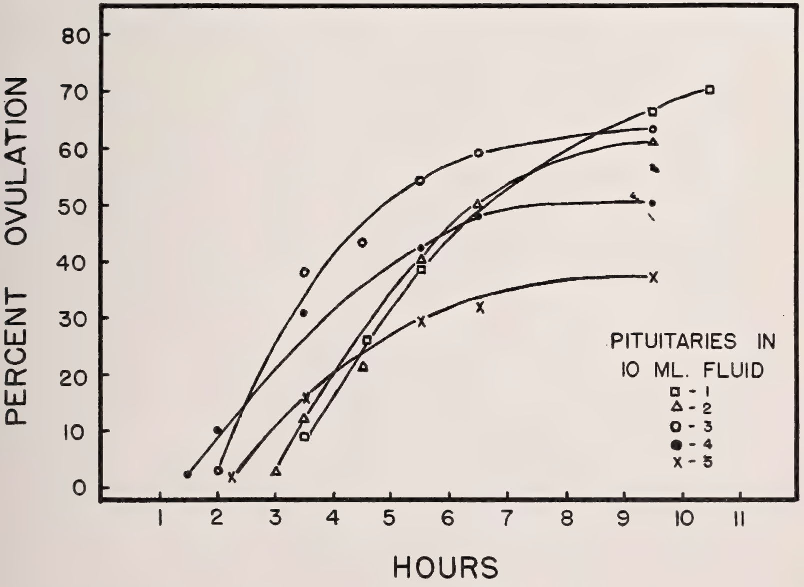

Figure 3. Effect of pituitary dilution upon the time required to initiate ovulation *in vitro*. Lower dilutions effected higher percentages of ovulation.

5. *Time Relationships.*—To determine the time required for the ovulation process to reach an equilibrium, experimentation was conducted in which the hourly progress of ovulation was recorded. Ovulation began about 3½ hours after the experiment was initiated, with approximately 75% of the eggs being ovulated in the following 3 hours, and was completed in 11½ hours. Maximal ovulation occurred in the sixth hour. Wright (1945) found that lower dilutions of pituitary took longer to initiate ovulation in the leopard frog. To test this for the spadefoot, a series of pituitary concentrations varying from 1 to 5 glands was effected. Ovulation was evoked in the 4 gland homogenate in 1½ hours; 3 gland—2 hours; 5—2½ hours; 2—3 hours; and 1—3½ hours (Fig. 3).

6. *Effect of Light.*—Since experiments were to be conducted at all hours, it seemed important to determine any effect of light upon the process. Ovaries removed under a photographic safe light and held in complete darkness showed no significant differ-

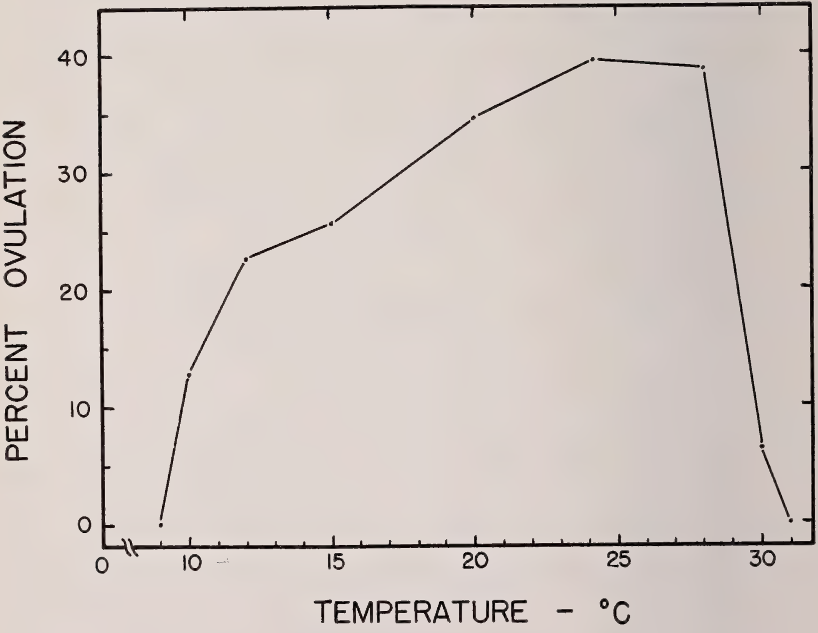

Figure 4. *In vitro* ovulation after exposure of ovarian fragments to a range of temperatures. Note the sudden inhibitory effect at higher temperatures.

ences in ovulation percentages from those exposed to constant light.

7. *Effect of Temperature.*—Wright (1945) found that *in vitro* ovulation in *R. pipiens* took place between temperatures of 17 to 32°C., with an optimum at about 22°C., and that no ovulation occurred at 12° or 37°C. A series of experiments on the spadefoot established definite temperature limits, showing that ovulation occurred between 10° and 30°C., with complete inhibition at 9° and 31°C. (Fig. 4).

8. *Effect of pH.*—Since little is known of the influence of pH upon the biocatalytic action of hormones, it seemed important to determine the effect of variable pH concentrations on the *in vitro* ovulation process. A phosphate buffering system (0.07M) was prepared in which the ratio of monobasic to dibasic sodium phosphate was varied to produce a pH gradient from 5.9 to 8.9. Each solution was secondarily checked with the Beckman pH meter after the addition of the pituitary homogenate. Ovulation *in vitro* occurred over a relatively wide range of hydrogen ion concentrations with maximal activity at 7.3. Complete inhibition was found below 6.5 and above 8.5 (Fig. 5). Rondell (1953), using *R. pipiens,* found that *in vitro* ovulation took place between pH values of 6.6 and 8.2, with complete inhibition at 6.0.

9. *Effect of Heteroplastic Pituitary Materials.*—Creaser and Gorbman (1939) after thoroughly reviewing the literature on induced ovulation in Amphibia, pointed out that the effectiveness of a gonadotropic hormone from a foreign species tends to vary directly with the phylogenetic affinity of the donor and recipient species. With this generalization in view, experimentation was conducted to establish the effects of heteroplastic pituitary materials upon the *in vitro* process.

Since the size and hormone titer of the pituitaries varied considerably, it was impossible to utilize the ovulation results for quantitative comparisons. The results were therefore listed simply as being positive or negative. The *in vitro* ovulation mechanism was found quite sensitive to heteroplastic pituitary homogenates. Ovulation was evoked using pituitary materials from the following: Amphibia *(Rana clamitans, R. pipiens sphenocephala, Microhyla c. carolinensis, Bufo t. terrestris, Hyla gratiosa, H. c. cinerea, Desmognathus fuscus auriculatus);* Reptilia *(Natrix taxispilota,* *Sceloporus u. undulatus);* Aves *(Gallus gallus);* Mammalia *(Sus scrofa, Ovis aries).* Negative results were obtained only in the Osteichthys *(Cynoscion nebulosus, Sciaenops ocellatus)* and with human chorionic gonadotropin extracts from pregnancy urine.

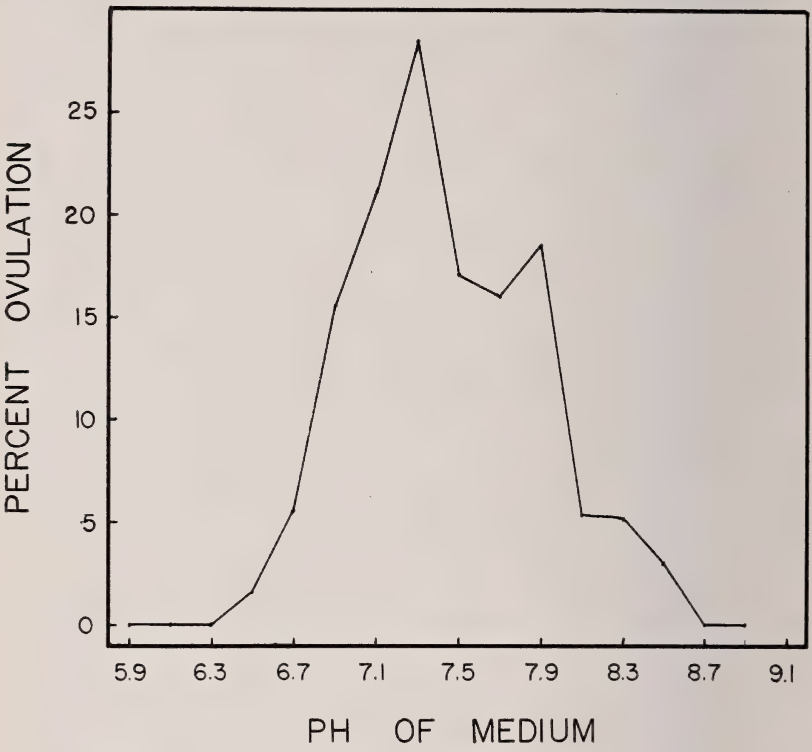

Figure 5. Effect of hydrogen ion concentrations upon *in vitro* ovulation.

Discussion

The question might be raised as to the validity of the *in vitro* ovulation process. Heilbrunn *et al.* (1939) pointed out that eggs ovulating *in vitro* showed polar body formation as normally ovulated ova. In 1940 Ryan and Grant successfully fertilized eggs ovulated *in vitro* after they had received jelly membranes from passing through the oviducts of an ovariectomized female. Wright (1945) showed that the relationship between percentages of ovulation and pituitary concentration is the same for both *in vivo* and *in vitro* techniques. The inhibition of *in vitro* ovulation due to large concentrations of pituitary, as shown by Wright (1945) and this work, is in accord with the observations of Foster *et al.* (1937) on the rabbit. Further, there is a striking similarity between the optimum (74°F.) and the upper (86°) and lower (50°) limiting temperatures in the *in vitro* tests and the range of temperatures at which Pearson (1955) found the spadefoot active; optimum, 69°; maximum, 84°, and minimum, 50°F. Also, in close accord with *in vitro* temperature ranges, are temperature records from 34 breeding choruses where spadefoots bred at temperatures ranging from 47° to 83°, with a mean of 71°F. Finally, it is well known that ovulation *in vivo* is stimulated by gonadotropic factors and that ovulation *in vitro* occurs only where pituitary has been used. Since the parallelism between *in vitro* and *in vivo* ovulation is so striking, it seems safe to conclude that the *in vitro* technique affords a valid method for studying ovulation in anurans.

In the spadefoot, the male pituitary was found to be about 78% as potent as the female gland, whereas Rugh (1948) reported that male *R. pipiens* pituitary had only about half the potency of the female pituitary. The difference between these two potency values may be solely specific. However, if this is not the case the present work would seem to be quantitatively more accurate since Rugh's work tested the intact females and was more or less concerned with an all or none response.

Whereas Wright (1945) obtained maximal ovulation in the leopard frog using 1/8 pituitary in 10 ml. of fluid, 1 gland in 10 ml. was required for the spadefoot. In both studies the number of eggs used was approximately the same. Also, the vitellus is almost identical in size for *R. pipiens* (1.3 - 2.0 mm.) and S. *h. holbrooki* (1.4 - 2.0 mm.). The difference is probably attributable to the greater size of the *pars distalis* of the leopard frog since the anterior lobe of the latter is two or three times that of the spadefoot. The larger gland would be expected to yield a higher hormone titer than the smaller spadefoot pituitary. The comparatively crude comparisons of gland size merely point up the need for standardized methods of hormone titer determination.

The shorter time required to initiate the onset of ovulation *in vitro* in the spadefoot (3½ hours) as compared to the leopard frog (10 hours) may possibly be due to an over-all acceleration of reproductive metabolism in the spadefoot. Trowbridge (1941) reported that the rate of embryonic and larval development is more rapid for the spadefoot than that reported in any other amphibian, and that the cell divisions are among the most rapid ever recorded.

Although Wright and Hisaw (1946) employed sheep pituitary extract for their *in vitro* work with *R. pipiens,* the present work is the first to make a wide utilization of heteroplastic pituitary materials. The negative results obtained with piscine pituitary are in accord with the majority of studies in which fish pituitaries were employed for the induction of *in vivo* ovulation in Amphibia (Creaser and Gorbman, 1935, 1939; Rostand, 1934). The low percentage of ovulation using salamander pituitary is in agreement with the work of Adams and Granger (1938) who found that *in vivo* ovulation in *R. pipiens* could only be induced with large numbers of *Triturus* pituitaries. The use of snake and lizard pituitary is the first successful attempt at stimulating gonad activity in Amphibia with reptilian glands. Although Stein (1934) and Witschi *et al.* (1937) induced ovulation in the newt *Triturus* using bird pituitary, the present study is the first to successfully utilize avian pituitary to induce ovulation in the Anura. The failure of chorionic gonadotropin from human pregnancy urine to initiate ovulation *in vitro* in *Scaphiopus* is not surprising, since Creaser and Gorbman (1939) point out that 9 of 12 anuran species failed to ovulate when subjected to human pregnancy urine. It is interesting to note that it is impossible to induce spermiation in the male spadefoot by the injection of human pregnancy urine (Hansen, 1951) or commercial human chorionic gonadotropin (Knepton, 1951).

SUMMARY

1. A study of *in vitro* ovulation employing 1007 male and female eastern spadefoots (*Scaphiopus h. holbrooki)* was conducted from May 1954 through July 1955.
2. Ovarian fragments were suspended on cotton threads in stoppered vials containing pituitary materials macerated in Holtfreter's solution. Percentages of ovulation were determined by dividing the number of eggs ovulated by the total number of eggs present in the ovarian fragment and multiplying by 100.

3. Male pituitary was found to be approximately 78% as potent as female pituitary in evoking ovulation *in vitro.*
4. Although individual variation in ovulation percentages were relatively high, no significant differences were obtained.
5. In experiments involving 371 *in vitro* tests, a very low correlation was found between the size of the pituitary donor and the degree of ovulation induced.
6. No relationship was found between the size of ovarian donors and the percentage of ovulation.
7. A dilution of 1 pituitary in 10 ml. of fluid evoked maximal *in vitro* ovulation, while concentrations above and below this dilution produced lower percentages of ovulation.
8. Using a dilution of 1 gland in 10 ml. of solution, ovulation began in 3½ hours and was completed after 11½ hours. Ovulation was most rapid in the 3 hours following its initiation, with a maximal peak during the third hour.
9. Light and darkness had no apparent effect upon the *in vitro* process.
10. *In vitro* ovulation occurred between 10° and 30°C., with an optimum temperature at about 24°C. Complete inhibition occurred at 9° and 31°C.
11. Ovulation *in vitro* occurred between pH values of 6.5 and 8.5, with maximal activity at 7.3, in a 0.07M sodium phosphate buffering system.
12. Heteroplastic pituitary materials from amphibian, reptilian, avian, and mammalian donors evoked ovulations, while piscine pituitary and human chorionic gonadotropin reacted negatively. The present study was the first to successfully utilize reptilian and avian pituitary for the induction of ovulation in the Anura.

LITERATURE CITED

ADAMS, A. E., and B. GRANGER
1938. Introduction of ovulation in *Rana pipiens* by pituitaries of *Triturus viridescens. Proc. Soc. Exp. Biol. and Med.,* 38: 552-554.

ASCHEIM, S.

1926. Uber die function des ovariums. *Ztschr. f. Geburtsh U. Gynak.*, 90: 387-390.

CREASER, C. W., and A. GORBMAN

1935. Apparent specificity of the induced ovulation reaction in amphibia. *Amer. Jour. Physiol.*, 113: 32.

1939. Species specificity of the gonadotropic factors in vertebrates. *Quart. Rev. Biol.*, 14(3): 311-331.

FOSTER, M. A., R. C. FOSTER, and F. L. HISAW

1937. The interrelationship of the pituitary sex hormones in ovulation, *corpus luteum* formation and *corpus luteum* secretion in the hypophysectomized rabbit. *Endocrinology*, 21: 249-259.

HANSEN, KEITH L.

1951. An investigation of native Florida male salientia as test animals for early pregnancy diagnosis. *Quart. Journ. Fla. Acad. Sci.*, 14(4): 231-236.

HEILBRUNN, L. V., K. DAUGHERTY, and K. M. WILBUR

1939. Initiation of maturation in the frog egg. *Physiol. Zool.*, 12: 97-100.

KNEPTON, J. C., JR.

1951. The responses of male salientia to human chorionic gonadotropic hormone. *Quart. Jour. Fla. Acad. Sci.*, 14(4): 255-265.

PEARSON, P. G.

1955. Population ecology of the spadefoot toad, *Scaphiopus h. holbrooki* (Harlan). *Ecol. Monogr.*, 25(3): 233-267.

RONDELL, P. A.

1953. *In vitro* studies on ovulatory mechanisms in the frog, *Rana pipiens*. Unpublished Ph.D. dissertation, Dept. of Biology, Univ. of Michigan. v + 52 pp.

ROSTAND, J.

1934. Hypophyse et ovulation chez les batraciens. *Compt. rend. Soc. de Biol.*, 117: 1079-1081.

RUGH, R.

1935. Ovulation in the frog. I Pituitary relations in induced ovulation. II Follicular rupture to fertilization. *Jour. Exp. Zool.*, 71: 149-193.

1948. *Experimental embryology, a manual of techniques and procedures*. Burgess Publ. Co., Minneapolis, vii + 480 pp.

RYAN, F. J., and R. GRANT

1940. The stimulus for maturation and for ovulation of the frog's egg. *Physiol. Zool.*, 13: 383-390.

SMITH, P. E.

1926. Hastening development of female genital system by daily homeoplastic pituitary transplants. *Proc. Soc. Exp. Biol.*, 6: 190-204.

STEIN, K. F.

1934. Effects of avian pituitary glands in salamanders. *Proc. Soc. Exp. Biol. and Med.*, 32: 157-161.

TROWBRIDGE, M. S.

1941. Studies on the normal development of *Scaphiopus bombifrons* Cope, I. The cleavage period. *Trans. Amer. Micros. Soc.*, 60: 508-526.

WITSCHI, E., A. J. STANLEY, and O. M. RILEY

1937. Gonadotropic hormones of the hypophysis of the turkey. *Proc. Soc. Exp. Biol. and Med.*, 36: 647-651.

WRIGHT, P. A.

1945. Factors affecting *in vitro* ovulation in the frog. *Jour. Exp. Zool.*, 100(3): 565-575.

1946. Sensitization of the frog ovary following hypophysectomy. *Physiol. Zool.*, 19(4): 359-364.

WRIGHT, P. A., and F. L. HISAW

1946. Effect of mammalian gonadotropins on ovulation in the frog, *Rana pipiens. Endocrinology,* 39(4): 247-255.

WRIGHT, P. A., and M. N. MACINTYRE

1950. Gonadotropic activity of blood serum from hypophysectomized frogs, *Rana pipiens. Physiol. Zool.*, 23(1): 16-22.

ZONDEK, B.

1926. Uberdie function des ovariums. *Ztsch. f. Gebrutsh, U. Gynak.*, 90: 372-374.

A CHECKLIST OF THE STOMATOPOD CRUSTACEANS OF THE FLORIDA - GULF OF MEXICO AREA

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Introduction

Very little is known about the stomatopod fauna of the western Atlantic. No comprehensive review of the western Atlantic species has yet appeared, although many papers have dealt with a few forms from localized areas. One paper lists the stomatopods of the Gulf of Mexico (Chace, 1954), but no workers have dealt with the stomatopods from the nearby Atlantic coast of Florida.

During the course of a review of the genus *Squilla* in the western Atlantic, new records of *Squilla* and other stomatopods have come to the attention of the author. As it might be some time before a complete review of the western Atlantic stomatopods can be completed, the author felt that a checklist of the species now known from the Florida-Gulf of Mexico area would be of value.

Five of the eight currently recognized genera of stomatopods have been reported from the Florida-Gulf of Mexico waters. Two of these genera, *Gonodactylus* and *Odontodactylus,* are each represented in the area by one species, although varietal forms have been reported for *Gonodactylus* from the Caribbean (Schmitt, 1924a, 1924b). *Pseudosquilla,* known previously from Florida and the Gulf by one species, is now represented by three. Chace (1958), in describing a new species of *Lysiosquilla* from Massachusetts, gave an excellent key to the eight western Atlantic species, three of which have been reported from Florida and the Gulf. Chace (1954) listed six species of *Squilla* from the Gulf of Mexico, and the present investigation has increased that number to eleven (plus one subspecies).

Historical Review

The earliest paper to record a stomatopod from Florida was that by Say (1818), who recorded *S. empusa* from southeast Florida. DeKay (1844) also recorded this species from that locality. Gibbes

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Contribution No. 234 from The Marine Laboratory, University of Miami, Florida.

(1850) recorded G. *oerstedii* from Key West, and von Martens (1872) described S. *rubrolineata* (now *dubia*) and recorded P. *ciliata* from Cuba. Ives (1891) reported S. *prasinolineata* from Yucatan, and Sharp (1893) listed L. *glabriuscula,* L. *scabricauda,* and G. *oerstedii* from Florida, and S. *empusa* from the Gulf.

Bigelow (1893) described four new species from Florida and the Gulf, S. *rugosa* from the Gulf, S. *intermedia* from the Gulf and the Bahamas, S. *quadridens* from east Florida, and O. *havanensis* from off Havana, Cuba. In 1894 Bigelow listed these and several other species from the Florida - Gulf of Mexico area in his report on the collections in the U. S. National Museum. Rathbun (1893) reported S. *empusa* from Texas, and Faxon (1896) also recorded this species from the Gulf.

Kemp (1913) reported S. *prasinolineata* from Cuba. McLendon (1911) and Pearse (1932) made observations on G. *oerstedii* at Dry Tortugas, and Lunz (1937) described S. *edentata* from the Gulf and S. *rugosa* var. *pinensis* from the Isle of Pines. Lunz also gave locality records for several other species from the Gulf. Chace (1939) described S. *heptacantha* from the southern coast of Cuba and (1942) O. *nigricaudatus* from the Gulf of Campeche. Chace has advised the author in a letter that O. *nigricaudatus* is a synonym of O. *havanensis* (Bigelow), and represents an older specimen than the latter. Anonymous (1942) and Behre (1950) listed three species from the Grand Isle, Louisiana, region and Chace (1954) summarized the known distribution of the species recorded from the Gulf.

The species are listed below in alphabetical order by genus, and the list includes only the adult forms. Following each specific name is a reference that may be used to identify the species. Notes on habitat and depth are given when possible. UMML is used for specimens in the collections in The Marine Laboratory, University of Miami, USNM for specimens in the U. S. National Museum collections, CHML for specimens at the Cape Haze Marine Laboratory, Placida, Florida, and FSBC for specimens at the State Board of Conservation Marine Laboratory at St. Petersburg, Florida. OREGON, SILVER BAY, and COMBAT refer to collections made by those U. S. Fish and Wildlife vessels in the Gulf of Mexico and tropical Atlantic. Some of the records herein listed for the OREGON have been published (Springer and Bullis, 1956). Station numbers have been given for the unpublished records, several of which are extensions of the range of the species involved, and the locality for these records may be obtained by referring to the station sheets released by the Fish and Wildlife Service. Localities without reference are those given by Chace (1954).

I am indebted to Dr. Fenner A. Chace, Jr., Curator, Division of Marine Invertebrates, U. S. National Museum, for reviewing this manuscript, for his invaluable advice on this problem, and for taking the time to provide many additional records as well as notes on depth and habitat from the collections of the National Museum. Thanks are due Harvey R. Bullis, Jr., Chief, Gulf Fisheries Exploration and Gear Research, who made available the recent stomatopod collection of the M/V OREGON, Dr. Eugenie Clark, Director, Cape Haze Marine Laboratory, Placida, Florida, who made available a large collection of stomatopods from the west coast of Florida, and Dr. Victor G. Springer of the Florida State Board of Conservation Marine Laboratory, St. Petersburg, Florida, who kindly loaned a large series of specimens from the Tortugas and Pensacola areas.

I also wish to express my thanks to Dr. C. Richard Robins and Dr. John E. Randall, The Marine Laboratory, University of Miami, for their special efforts to obtain specimens while in the field, and to the other students and staff members who collected a great deal of the material now stored there.

A special word of thanks is due Dr. Gilbert L. Voss, Curator of Marine Invertebrates at The Marine Laboratory, for directing my attention to this interesting group and for his constant help and editorial advice.

Systematic List

Class Crustacea
Division Hoplocarida
Order Stomatopoda
Family Squillidae

Genus *Gonodactylus* Latreille, 1825

G. oerstedii Hansen, 1895. Bigelow, 1902.

Florida: Biscayne Bay, Soldier Key, Crocker Reef, Plantation Key, Long Key, Bahia Honda, Sand Key, Key West, Dry Tortugas, (all UMML), Fort Myers (CHML), Clearwater (CHML), Gulf, north of Anclote Keys (FSBC), Gulf, west of Florida (OREGON Sta. 276), Gulf, southeast of Apalachicola (SILVER BAY Sta. 581). Also North Carolina to Brazil; Bermuda (UMML); Bahamas (UMML); eastern Pacific from Gulf of California to Ecuador (Schmitt, 1940); Galapagos (USNM). From 0 to 70 fms. in rock, coral and sponge.

Genus *Lysiosquilla* Dana, 1852

L. excavatrix Brooks, 1886. Chace, 1958.

Florida: west of Charlotte Harbor. Alabama: Mobile. Mississippi: Petit Bois Island (USNM). Louisiana: Grand Isle. Texas: Port Aransas (USNM). Also North Carolina; Sao Paulo, Brazil (Lemos de Castro, 1955). Littoral, in sand.

L. glabriuscula (Lamarck, 1818). Chace, 1958.

Florida: Lake Worth (USNM), Biscayne Bay (UMML), off Fowey Light (USNM), Key West (Sharp, 1893), Garden Key, Dry Tortugas (Bigelow, 1894), Gulf Coast (CHML). Also South Carolina to Brazil, including the Antilles (Holthuis, 1941). Littoral.

L. scabricauda (Lamarck, 1818). Chace, 1958.

Florida: Indian River, Fort Pierce, Biscayne Bay, Key West (all UMML), Placida (CHML), Lemon Bay (CHML), Gasparilla Sound (CHML), Sanibel Island, Longboat Key, Manatee County (USNM), Johns Pass, and Pensacola. Louisiana: Grand Isle, Breton Island (USNM), off Chandaleur Island (USNM), Timbalier (USNM). Texas: Galveston, Aransas Pass (USNM). Gulf of Campeche: off "west coast of Yucatan" (USNM), Obregon (USNM). Also New England to Brazil; West Africa (Holthuis, 1941). Littoral to 27 fms. in sand and mud.

Genus *Odontodactylus* (Bigelow, 1893)

O. havanensis (Bigelow, 1893). Bigelow, 1894.

Florida: Key West, Dry Tortugas, S.W. of Boca Grande (CHML). Campeche Bank and Gulf of Campeche. Also Cuba; Bahamas; Curacao. Littoral to 163 fms.

Genus *Pseudosquilla* Dana, 1852.

P. *ciliata* (Fabricius, 1787). Bigelow, 1902.

Florida: Biscayne Bay (UMML), Soldier Key (UMML), Key Largo (USNM), Lower Matecumbe (USNM), Ohio Key (UMML), Key Vacca (USNM), No Name Key (USNM), Indian Key (USNM), Key West (UMML). Also Bermuda and Bahamas (UMML) to Brazil; Indo Pacific (Schmitt, 1940). Littoral to 66 fms., in rock, coral and sponge.

P. *oculata* (Brulle, 1835-1844). Schmitt, 1940.

Florida: ½ mile off Matecumbe Key, Atlantic side (UMML). Also Brazil (Lemos de Castro, 1955); Canary Islands; Madeira; Cape Verde Islands; east and west Pacific (Schmitt, 1940). Littoral to 2 fms.

P. *plumata* (Bigelow, 1902). Bigelow, 1902.

Florida: off Sand Key (Key West) (UMML). Also Mayaguez Harbor, Puerto Rico (Bigelow, 1902). 25 - 30 fms.

Genus *Squilla* Fabricius, 1787.

S. *alba* Bigelow, 1893. Bigelow, 1894.

Florida: Biscayne Bay (UMML). Also Bimini Harbor, Bahamas (Bigelow, 1893); Curacao (Schmitt, 1924a); Saint Helena (Ingle, 1958); South Africa (Ingle, 1958); Hawaii (?) (Townsley, 1953). Littoral, burrowing in sand or rock

S. *brasiliensis* Calman, 1917. Calman, 1917.

Gulf of Mexico: northern Gulf (SILVER BAY Sta. 181), Gulf of Campeche (OREGON Sta. 1060), and 16 OREGON Stations. Also off Trinidad (USNM; OREGON Stats. 2207, 2208, 2209); off Venezuela (UMML); north of British Guiana (OREGON Stats. 2276, 2237); Cape Frio, Brazil (Calman, 1917); Uruguay (Hansen, 1921). 12 to 200 fms. in mud and broken shell.

S. *dubia* H. Milne Edwards, 1837. Schmitt, 1940.

Florida: Port Everglades (UMML). Also Charleston, South Carolina to Rio de Janeiro, Brazil, including Georgia, British Honduras, Cuba, Santo Domingo, Trinidad, Lemon Bay, Panama; west coast of America from El Triunfo, El Salvador to Rio Tumbes, Peru (Schmitt, 1940). Littoral, in sand and mud.

S. *edentata* (Lunz, 1937). Lunz, 1937.

Florida: W.S.W. of Pensacola in 120 fms.

S. *empusa* Say, 1818. Calman, 1917.

Florida: Fernandina (USNM), St. Augustine (USNM), Matanzas Inlet (Lunz, 1937), Biscayne Bay (UMML), Marathon (UMML), Key West (USNM), Dry Tortugas shrimp grounds (north and east of Dry Tortugas) (UMML), off Englewood (USNM), Sanibel Island (Lunz, 1937), Tampa Bay (USNM), Cedar Keys (USNM), Apalachicola Bay (FSBC), off Cape San Blas (USNM), Choctawhatchee Bay (USNM), Pensacola Bay (FSBC). Alabama: Mobile Bay near Cedar Point (USNM). Mississippi: Ocean Springs (UMML), Mississippi Sound off Horn Island (USNM). Louisiana: Cameron (USNM), Breton Island (USNM); Grand Isle. Texas: Galveston, Rockport (USNM), Corpus Christi Bay (USNM), Aransas Pass (USNM). Gulf of Mexico: 10 OREGON stations and northern Campeche Bank. Also Massachusetts to French Guiana (OREGON Sta. 2327), including Trinidad (OREGON Stats. 2208, 2209), and Surinam (OREGON Sta. 2279). Erroneously recorded from Brazil and West Africa. Lemos de Castro (1955) knew of no Brazilian records, and Calman (1916) redescribed the West African records as S. *africana*. From 0 to 84 fms. in sand, mud, and broken shell.

S. *heptacantha* (Chace, 1939). Chace, 1939.

Florida: off Daytona Beach (COMBAT Sta. 235), off Fort Pierce in 230 fms. (OREGON Sta. 1340). Bahia de Cochinos, Santa Clara Province, Cuba, 180-190 fms.; Old Bahama Channel, due north of Punta Alegre, Camaguey Province, Cuba, 150-180 fms. (Chace, 1939). From 150 to 250 fms.

S. *intermedia* Bigelow, 1893. Bigelow, 1894.

Florida: off Daytona Beach (COMBAT Sta. 235), off Fort Pierce (COMBAT Stats. 237, 238). Gulf of Mexico: off Mississippa delta, (SILVER BAY Sta. 182) and 8 OREGON stations. Also north of Cuba (OREGON Stats. 1343, 1344); Little Bahama Bank; Puerto Rico; Caribbean Sea (OREGON Sta. 1883); Curacao (USNM); north of British Guiana (OREGON Sta. 1983); north of Surinam (OREGON Stats. 2286, 2288, 2285); north of French Guiana (OREGON Sta. 2295). From 30 to 250 fms. in mud, sand, and broken shell.

S. *neglecta* Gibbes, 1850. Lemos de Castro, 1955.

Florida: Lemon Bay, Gulf Coast (CHML), Sanibel Island, Gulf of Mexico, north of Key West (OREGON Sta. 993). Also North and South Carolina; Brazil (Lemos de Castro, 1955). Littoral to 35 fms.

S. *prasinolineata* Dana, 1852. Lemos de Castro. 1955.

Florida: Miami (UMML), Flamingo, Florida Bay (UMML). Gulf of Mexico: Yucatan (Ives, 1891). Also Cuba (USNM; Kemp, 1913); St. Thomas (USNM); Brazil (Lemos de Castro, 1955). S. *prasinolineata* Miers, 1880, is probably not this species. Dr. Chace has informed the author that there are three specimens from Cape Hatteras, one from Pensacola, and one without data in the National Museum that had been identified by Miss (Mary J.) Rathbun as S. *prasinolineata* Miers, not Dana.

S. *quadridens* Bigelow, 1893. Bigelow, 1894.

Florida: Biscayne Bay (UMML), off Key Largo (Bigelow, 1893), Englewood Beach (CHML), Northwest Gulf of Mexico (OREGON Stats. 896, 899). Also Gairaca, Santa Marta (Holthuis, 1941). From 0 to 56 fms. in sand.

S. *rugosa* Bigelow, 1893. Bigelow, 1894.

Florida: Biscayne Bay (UMML), Tortugas shrimp grounds (north and east of Dry Tortugas) (UMML), west coast of Florida (OREGON Sta. 907), Charlotte Harbor; Pensacola (USNM). Gulf of Mexico (OREGON Stats. 449, 1050; SILVER BAY Sta. 71). Also south of Cuba (OREGON Sta. 713); Little Bahama Bank (UMML); north of British Guiana (OREGON Stats. 2244, 2249); north of Surinam (OREGON Stats. 2262, 2267, 2276). To 39 fms. in sand and broken shell.

S. *rugosa pinensis* (Lunz, 1937). Lunz, 1937.

Florida: off east coast in 30 fms. (COMBAT Sta. 334). Also Siguanea Bay, Isle of Pines, Cuba (Lunz, 1937). This subspecies may prove to be a normal variant of S. *rugosa* sp.

Discussion

Of the 29 western Atlantic stomatopods, 19 are known from the Florida - Gulf of Mexico area (Table 1). Ten of the Florida -

Gulf species have extensive ranges, at least from Florida to Brazil, and only one *(S. edentata)* is not known outside of the Gulf. Of the ten western Atlantic species not recorded from the Gulf, all but one are known from only one or two localities.

TABLE 1

Numbers of species of stomatopods in the western Atlantic and the Florida-Gulf of Mexico area.

Genus	Western Atlantic	Florida-Gulf of Mexico
Gonodactylus	1, and 2 subspecies	1
Hemisquilla	1	0
Lysiosquilla	8	3
Odontodactylus	1	1
Pseudosquilla	4	3
Squilla	14, and 1 subspecies	11, and 1 subspecies
Total	29, and 3 subspecies	19, and 1 subspecies

The majority of western Atlantic species are tropical or subtropical forms. Five are temperate, and one is sub-antarctic. Three of the 29 species are also known from the eastern Atlantic, and five are known from the Pacific and Indian Oceans. There are several pairs of closely related species in the eastern Pacific and western Atlantic (Schmitt, 1940). Much future work is needed to clarify the zoogeographic relations of this group.

Literature Cited

ANONYMOUS

1942. Annotated list of the fauna of the Grand Isle Region 1928-41. *Mar. Lab. Louisiana State Univ.*, pp. 1-20.

BEHRE, ELLINOR H.

1950. Annotated list of the fauna of the Grand Isle Region 1928-46. *Occ. Pap. Mar. Lab. Louisiana State Univ.*, No. 6:1-66.

BIGELOW, ROBERT PAYNE

1893. Preliminary notes on the Stomatopoda of the "Albatross" collections and on other specimens in the National Museum. *Johns Hopk. Univ. Circ.*, 12(106):100-102.

1894. Report on the Crustacea of the order Stomatopoda collected by the steamer "Albatross" between 1885 and 1891, and on other specimens in the U. S. National Museum. *Proc. U. S. Natl. Mus.*, 17: 489-550.

1902. The Stomatopoda of Porto Rico. *Bull. U. S. Fish. Comm.*, 20(2): 151-160.

CALMAN, W. T.

1916. A new species of the Crustacean genus *Squilla* from West Africa. *Ann. Mag. Nat. Hist.*, 18(8):373-376.

1917. Arthropoda. Part IV, Stomatopoda, Cumacea, Phyllocarida and Cladocera. *Brit. Antarct. Terra Nova Expedition, 1910. Natural History Reports, Zoology,* 3(5):138-145.

CHACE, FENNER A., JR.

1939. Preliminary descriptions of one new genus and seventeen new species of decapod and stomatopod Crustacea. *Mem. Soc. Cubana Hist. Nat.*, 13:31-54.

1942. Six new species of decapod and stomatopod Crustacea from the Gulf of Mexico. *Proc. New England Zool. Club,* 19:79-92.

1954. Stomatopoda. *In:* Gulf of Mexico, its origin, waters, and marine life. Fish. Bull., *U. S. Fish & Wildlife Serv.*, 89:449-450.

1958. A new stomatopod crustacean of the genus *Lysiosquilla* from Cape Cod, Massachusetts. *Biol. Bull.*, 114(2):141-145.

FAXON, WALTER

1896. Supplementary notes on the Crustacea. *In:* Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico. *Bull. Mus. Comp. Zool. Harvard,* 30(3):153-166.

GIBBES, L. R.

1850. On the carcinological collections of the United States, and an enumeration of the species contained in them, with notes on the most remarkable, and descriptions of new species. *Proc. Amer. Assoc. Adv. Sci.*, 3rd Meeting:199-201.

HANSEN, H. J.

1921. On some malacostracous Crustacea collected by the Swedish Expeditions. *Ark. Zool.*, 13(20):7.

HOLTHUIS, L. B.

1941. Notes on some Stomatopoda from the Atlantic coasts of Africa and America, with the description of a new species. *Zool. Meded.*, 23:31-43.

INGLE, R. W.

1958. On *Squilla alba* Bigelow, a rare stomatopod crustacean new to St. Helena and South Africa. *Ann. Mag. Nat. Hist., 13th Ser.*, 1(1): 49-56.

IVES, E. J.

1891. Crustacea from the northern coast of Yucatan, the harbor at Vera Cruz, the west coast of Florida, and the Bermuda Islands. *Proc. Acad. Nat. Sci. Philad.,* 43(1):184-185.

KAY, J. E. DE

1844. Zoology of New York, Part 6. Crustacea:31-33.

KEMP, STANLEY

1913. An account of the Crustacea Stomatopoda of the Indo-Pacific region. *Mem. Indian Mus.,* 4:1-217.

LEMOS DE CASTRO, ALCEU

1955. Contribuicao ao conhecimento dos crustaceos da ordem Stomatopoda do litoral brasileiro (Crustacea, Hoplocarida). *Bol. Mus. Nac. Rio de Janeiro, neva serie, Zool.,* No. 128:1-68.

LUNZ, G. ROBERT, JR.

1937. Stomatopoda of the Bingham Oceanographic Collection. *Bull. Bingham Oceanogr. Coll.* 5(5):1-19.

MARTENS, E. VON

1872. Ueber Cubanische Crustaceen. *Arch. Naturgesch.,* 38(1):144-147.

McCLENDON, JESSE F.

1911. On adaptations in structure and habits of some marine animals of Tortugas, Florida. *Pap. Tortugas Lab., Carnegie Inst. Washington,* 3:55-62.

MIERS, E. J.

1880. On the Squillidae. *Ann. Mag. Nat. Hist.,* 5(5):1-30, 108-127.

PEARSE, ARTHUR S.

1932. Inhabitants of certain sponges at Dry Tortugas. *Pap. Tortugas Lab., Carnegie Inst. Washington,* 28:117-124.

RATHBUN, MARY JANE

1893. List of Crustacea collected. *In:* Barton Warren Evermann, A report upon investigations made in Texas in 1891. *Bull. U. S. Fish. Comm.,* 11:61-90.

SAY, THOMAS

1818. An account of the Crustacea of the United States. *Jour. Acad. Nat. Sci.,* 1:250-253.

SCHMITT, WALDO L.

1924a. The Macruran, Anomuran, and stomatopod Crustacea. Fauna von. Curaçao. *Bijdr. Dierk.,* 23:80.

1924b. Report on the Macrura, Anomura, and Stomatopoda collected by the Barbados-Antigua Expedition. *Univ. Iowa Studies Nat. Hist.,* 10(4):96-98.

1940. The stomatopods of the west coast of America based on collections made by the Allen Hancock Expeditions, 1933-38. *Allan Hancock Pacif. Exped.*, 5(4):129-255.

SHARP, BENJAMIN
1893. Catalogue of the crustaceans in the Museum of the Academy of Natural Sciences of Philadelphia. *Proc. Acad. Nat. Sci., Philad.*, 1893:105-108.

SPRINGER, STEWART, and HARVEY R. BULLIS, JR.
1956. Collections by the "Oregon" in the Gulf of Mexico. *Spec. Sci. Rep. U. S. Fish & Wildlife Serv.*, 196:1-134.

TOWNSLEY, SIDNEY J.
1953. Adult and larval stomatopod crustaceans occurring in Hawaiian waters. *Pacif. Sci.*, 7(4):399-437.

EXTRUSIVE INCISOR GROWTH IN THE RODENT GENERA *GEOMYS, PEROMYSCUS,* AND *SIGMODON*

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The rates of incisor growth in various rodents and lagomorphs have been studied by various workers since attention was directed to the growth of these teeth in *Rattus norvegicus* by Shadle, Wagner, and Jacobs in 1936. The upper incisors of *Oryctolagus* (Shadle, 1936), *Rattus losea* (Huruhata, 1940), *Cavia* (Shadle, Valvo, and Eckhart, 1938) and *Erethizon* (Shadle, Ploss, and Marks, 1944) have been found to grow between 2.65 and 4.54 inches annually while the lower incisors have an annual growth between 3.55 and 6.36 inches, each genus being fairly distinguishable from the others. More recently, Howard and Smith (1952) and Miller (1958) found that the western pocket gopher, *Thomomys,* had markedly higher rates than those animals previously studied, the differences presumably being due to the fossorial habits of those rodents.

The purpose of this paper is to present data on the rates of incisor growth in another geomyid species, *Geomys pinetus,* and two cricetid rodents, the cotton mouse *(Peromyscus gossypinus)* and cotton rat *(Sigmodon hispidus).*

The author is indebted to Dr. James N. Layne for his valuable assistance and helpful criticism in preparing this paper.

Materials and Methods

Measurements were made on two individuals each of the three species studied. All of the animals were collected in the vicinity of Gainesville, Alachua County, Florida. The animals were housed in laboratory cages and fed a balanced diet of commercial rodent food, fresh greens, carrots, and potatoes. Incisor growth measurements and body weights were recorded at 7-day intervals. A file was used to make a transverse notch close to the gingival margin of one upper and one lower incisor and the distance between the notch and gum-line was recorded to the nearest 0.1 mm. by means of a vernier caliper. At each subsequent examination the distance between the previous notch and gingival was recorded and a new notch was made. Measurements were continued over a period of

28 days for each of the six animals except in the case of a female *Peromyscus gossypinus.* This animal, which was pregnant when captured and gave birth to young in captivity, was studied over an interval of 35 days to obtain data on the influence of lactation on incisor growth.

RESULTS

Geomys pinetus had the greatest absolute and relative incisor growth rates of the three species studied (Table 1). Growth of the upper incisor averaged 0.35 mm. per day while the lower incisor averaged 0.67 mm. per day.

TABLE 1

BODY WEIGHTS AND RATES OF EXTRUSIVE INCISOR GROWTH.

Species and Individual	Body Weight (gms.)			Upper		Lower	
	Mean	S.D.	Range	Total	mm/day	Total	mm/day
Peromyscus gossypinus No. 1	30.6	1.45	29.4- 32.8	3.8	0.14	9.9	0.35
Peromyscus gossypinus No. 2	39.7	0.98	38.8- 40.9	4.2	0.15	9.6	0.34
Sigmodon hispidus No. 1	171.5	9.64	159.5-184.6	6.2	0.22	10.1	0.36
Sigmodon hispidus No. 2	133.8	4.45	128.6-140.1	4.6	0.16	10.3	0.37
Geomys pinetis No. 1	106.5	6.69	96.6-114.4	10.2	0.36	19.6	0.70
Geomys pinetis No. 2	99.6	2.60	97.4-103.1	9.4	0.34	18.0	0.64

Corresponding rates in the cotton rat were 0.19 mm. and 0.36 mm. and in the cotton mouse, 0.16 mm. and 0.34 mm. per day. No individual differences were noted except in the case of the two cotton rats where a significant difference existed in the growth rates of the upper incisors (Table 1). Whether this variation is attributable to the differences in body weights (Table 1) is questionable. Although the absolute rates of the pocket gropher and cotton rat were quite different, the differential growth rate of upper and lower incisors was 52 per cent in both species. The differential rate in the cotton mouse, however, was only 42 per cent, which is lower than any species reported.

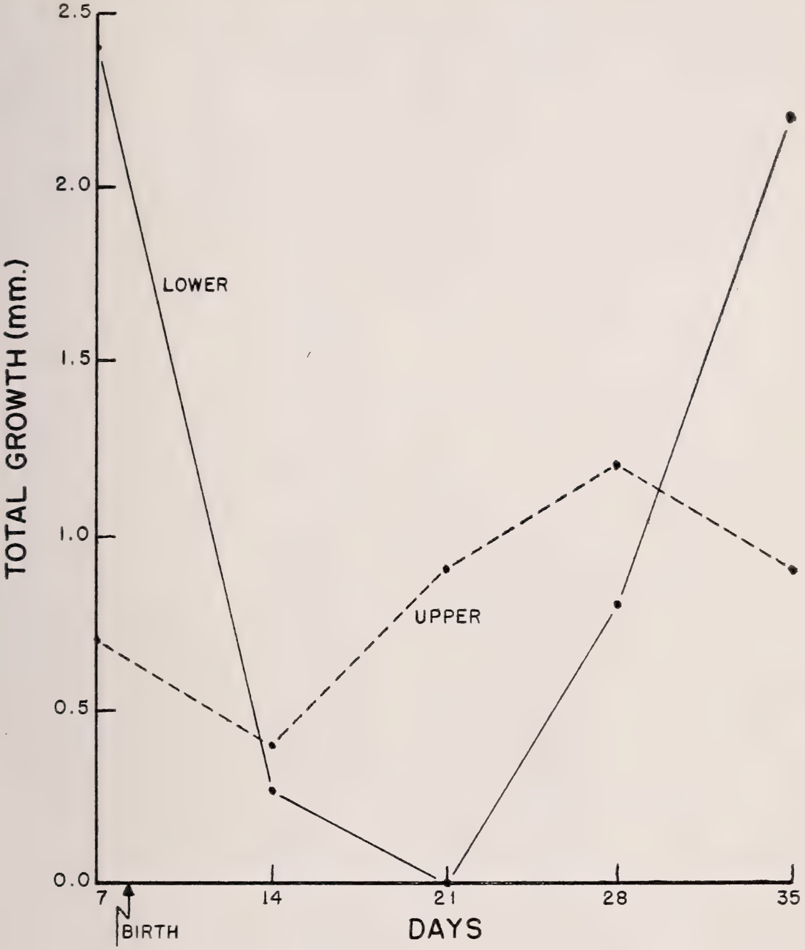


Figure 1. Incisor growth of lactating *Peromyscus gossypinus.*

The upper incisor of the pregnant cotton mouse grew 0.70 mm. and the lower, 2.40 mm. in the week prior to parturition. At the end of the following week, the upper incisor had grown only 0.40 mm. and the lower, only 0.30 mm. (Figure 1). No growth was recorded for the lower incisor during the next week, whereas the uppers resumed normal growth. During the 21-28 day period, the young began to consume small amounts of water and solid food and the lower incisor of the lactating female grew 0.80 mm.

The young were weaned by the 30th day and measurements taken on the 35th day indicated that the lower incisors were again growing at the pre-partum rate.

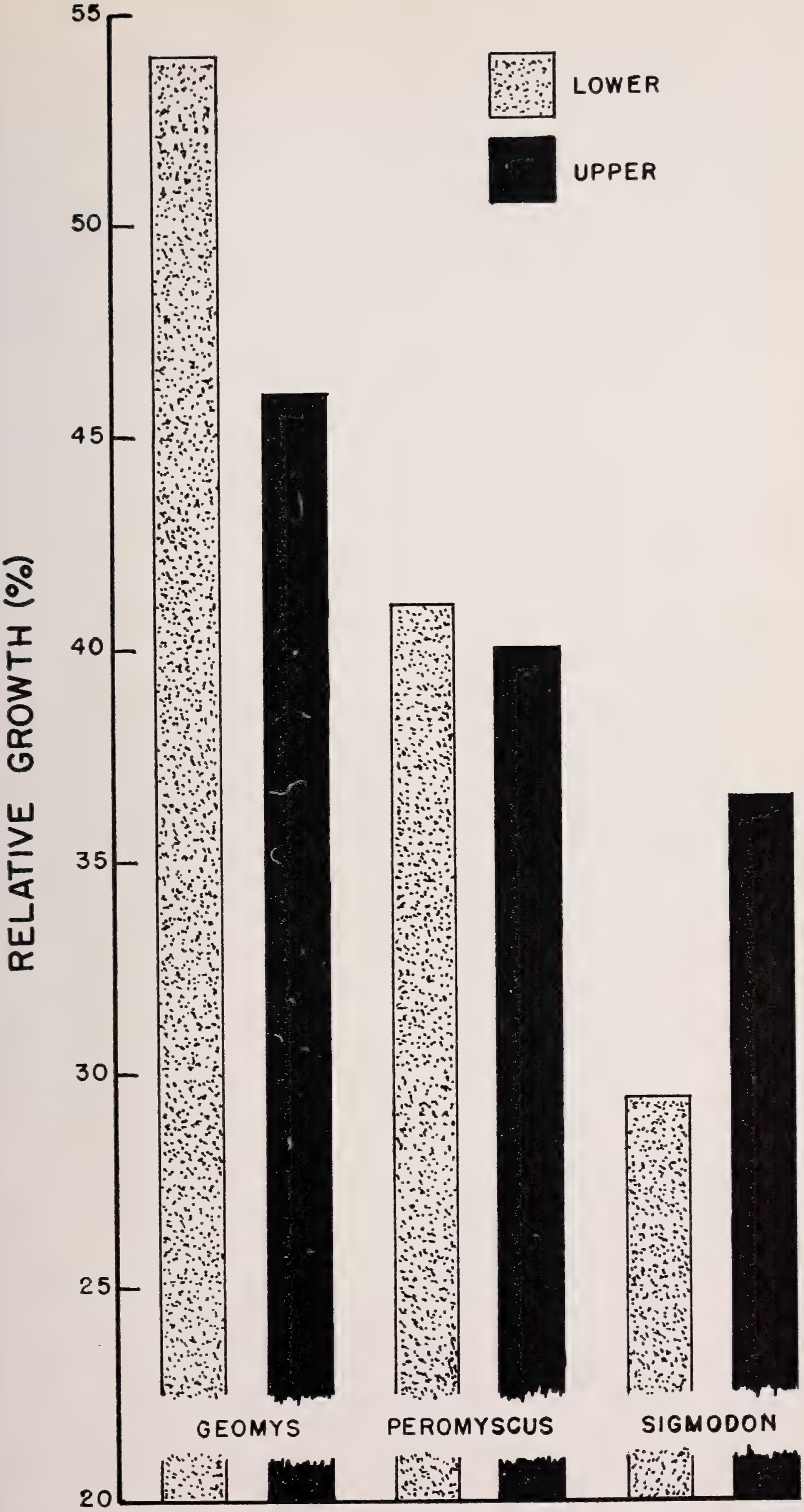
The absolute differences between the mean lower incisor rates of all three species studied were significant at the 99 per cent level. The differences between the growth rates of the upper incisors of *Geomys* and both *Sigmodon* and *Peromyscus* are also significant at the 99 per cent level, while those of the cotton rat and cotton mouse are not ($p = .60$).

Discussion

The present data indicates that *Geomys* shares a relatively high incisor growth rate similar to *Thomomys*. However, the values reported for the western pocket gopher by Howard and Smith (1952) and Miller (1958) average slightly more (0.24 mm. per day for the upper incisors and 0.32 mm. per day for the lowers) than in the eastern form. The significance of this difference is not obvious, although it may be related to differences in diet or the soils that are inhabited. The cotton rat fell considerably below *Geomys* in its incisor growth rates, which correspond rather closely to those reported for the procupine. The rates observed in *Peromyscus* are the lowest of the three species studied. However, the differential growth rate of upper and lower incisors is less (42 per cent as compared to 52 per cent) than in *Geomys* and *Sigmodon*.

Figure 2 presents the average weekly incisor growth in the three species as a percentage of the mean length of the respective incisor in each form, thus permitting a comparison of relative incisor growth in each species. On this basis *Geomys* still exceeds the other in incisor growth rates. However, a comparison of *Peromyscus* and *Sigmodon* shows that the former replaces 40.7 per cent of the lower incisor per week and 40.0 per cent of the upper incisor, while corresponding values for *Sigmodon* are 29.3 and 36.5 per cent. Howard and Smith (1952) and Miller (1958) postulate that apparent differences in the incisor growth rates between two species of *Thomomys* were largely due to varying feeding habits. The same hypothesis appears tenable in the

Figure 2. Relative growth of incisors expressed as a percentage of total length of tooth.


RELATIVE GROWTH (%)
55
50
45
40
35
30
25
20
LOWER
UPPER
GEOMYS
PEROMYSCUS
SIGMODON

present case as the cotton rat habitually feeds on soft vegetation while the cotton mouse tends to subsist on harder fare.

In the case of the pregnant female cotton mouse studied, lactation was found to have a pronounced effect on incisor growth rates, the lowers, because of their inherently high rates, reflecting to a greater degree the influence of nursing on calcium and phosphorus levels.

Summary

The rate of extrusive incisor growth in the rodents *Geomys pinetis, Sigmodon hispidus,* and *Peromyscus gossypinus* was studied over a 28-day period. The upper incisors of *Geomys* grew at an average rate of 2.45 mm. per week and the lowers, 4.69 mm. per week. The mean rates of upper and lower incisors of *Sigmodon* were 1.33 and 2.52 mm. per week, respectively, and for *Peromyscus,* 1.12 and 2.38 mm. Differential growth rates of the incisors in the three species were: *Geomys,* 52 per cent; *Sigmodon,* 52 per cent; and *Peromyscus,* 42 per cent.

Geomys exceeded the other genera in relative as well as absolute growth of incisors, while growth rates of *Peromyscus* incisors were proportionately higher than *Sigmodon.* These differences may be correlated with differences in dietary habits.

A single *Peromyscus* female exhibited a marked reduction in the growth of the lower incisors during lactation. The effect of nursing on the growth of the upper incisors was much less and of shorter duration.

Literature Cited

HOWARD, WALTER E., and MELVIN E. SMITH
1952. Rate of extrusive growth of incisors of pocket gophers. *Journ. Mammal,* 33:485-487.

HURUHATA, KITAO
1940. On the attrition and extrusive growth of the incisors in a Formosan rat, *Rattus losea* (Swinhoe). *Journ. Soc. Trop. Agric.,* 12: 171-182.

MILLER, RICHARD S.
1958. Rate of incisor growth in the mountain pocket gopher. *Journ. Mammal,* 39:380-385.

SHADLE, A. R.
1936. The attrition and extrusive growth of four major incisor teeth of domestic rabbits. *Journ. Mammal,* 17:15-21.

SHADLE, A. R., W. R. PLOSS, and E. M. MARKS
1944. The extrusive growth and attrition of the incisor teeth of *Erethizon dorsatum*. *Anat. Rec.*, 90:337-341.

SHADLE, A. R., N. I. VALVO, and K. H. ECKHART
1938. The extrusive growth and attrition of the incisor teeth of *Cavia cobaya*. *Anat. Rec.*, 71:497-502.

SHADLE, A. R., L. G. WAGNER, and T. JACOBS
1936. The extrusive growth and attrition of the incisors in albino and hybrid *Rattus norvegicus* (Erxleben). *Anat. Rec.*, 64:321-325.

A COMPARISON OF *TRACHINOTUS CAYENNENSIS* WITH *T. CAROLINUS* AND *T. PAITENSIS*[1]

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Trachinotus cayennensis Cuvier (Cuvier and Valenciennes, 1831: 417)[2] was described from a specimen two and one-half inches long, from Cayenne, French Guiana, and was distinguished from other *Trachinotus* indigenous to the Western North Atlantic by its high dorsal and anal fin soft-ray formulae and its low number of dorsal spines: D. V-I, 27; A. II-I, 26. Its other characters, as given by Jordan (1886: 531), are depth (2 in length) and a "very large eye." The holotype is the only specimen of the Cayenne pompano previously discussed in the literature.

Pompanos bearing high dorsal and anal fin-ray formulae taken off Venezuela and British Guiana by the U. S. Fish and Wildlife Service M/V *Oregon*, and off Surinam by the M/V *Coquette,* a vessel operated under contract to the Government of Surinam, were identified as *T. cayennensis.*

The only *Trachinotus* in the Western North Atlantic approaching *T. cayennensis* in fin-ray formulae is the common pompano, *T. carolinus* (Linnaeus). *T. paitensis* Cuvier (Cuvier and Valenciennes, 1831: 438),[2] of the Pacific coast of Central America and northern South America, also shows affinities to *T. cayennensis* (Meek and Goss, 1884: 129). Therefore *T. cayennensis* will be compared with these species. My data are shown in Table 1, and are supplemented by Hildebrand's (1946: 215-16) data for *T. paitensis.*

Definitions and Methods

All measurements were made with dividers and a rule. Those below 50 mm. were recorded to the nearest tenth mm., all above 50 mm., to the nearest half-millimeter.

Fin-ray counts: Roman numerals indicate spines; Arabic numerals indicate soft-rays. A dash indicates separation of the spinous from the soft fin, and a comma denotes a membrane connection or inclusion, as between the spine and the first soft-ray in all soft fins but the caudal.

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[1] Contribution Number 45 from the U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries Biological Laboratory, Brunswick, Georgia.

[2] Authority according to Bailey, 1951.

Gill-raker counts: The first number indicates those rakers on the upper limb of the first gill arch; the number following the plus-sign represents those at the angle and on the lower limb. Rudiments are included where discernible, but tubercles at the ends of the arch are ignored.

Teeth: Each specimen was examined for dental development on premaxillary, vomer, palatines, tongue, and mandible.

Standard length, total length, head length, snout length and eye diameter were measured parallel to the longitudinal axis of the fish; depth was measured from the insertion of first anal spine to insertion of last dorsal spine. Snout to first dorsal spine, snout to first anal spine, and dorsal and anal base lengths are direct measurements. Dorsal and anal lobe lengths are from insertion of last spine to tip of lobe; paired fin lengths, from spine insertion to tip of fin. Caudal lobe length is the direct distance from anteriormost dorsal secondary caudal ray to tip of upper caudal lobe.

All specimen lengths are standard lengths unless otherwise stated.

Abbreviations are: USNM, United States National Museum; CNHM, Chicago National History Museum; UF, University of Florida Collections; *Ore.*, M/V *Oregon* specimens housed uncataloged in the collections of the Bureau of Commercial Fisheries, Biological Laboratory, Brunswick, Georgia (BLBG).

List of Specimens

Six specimens of *T. cayennensis* were examined: CNHM 64486, 193 mm., taken June 1-2, 1957, Lat. 06°20′ to 06°19′ N, Long. 54°54′ to 54°49′ W, *(Coquette)*; CNHM 64522-1 and -2, 306 and 299 mm., taken August 27, 1958, Lat. 09°29′ N, Long. 60°30′ W, (*Oregon* sta. 2214); USNM 159832, 205.5 mm., taken May 30, 1957, Lat. 06°23′ to 06°20′ N, Long. 54°47′ to 54°51′ W, (*Coquette* sta. 155); *Ore* 2225, 199 mm., taken August 28, 1958, Lat. 08°32′ N, Long. 59°10′ W, (*Oregon* sta. 2225); *Ore.* 2214, 325 mm., taken August 27, 1958, Lat. 09°29′ N, Long. 60°30′ W, (*Oregon* sta. 2214).

One *T. paitensis,* USNM 77686, 285 mm., was examined from Lobos de Tierra, Peru.

Sixteen *T. carolinus,* 150.5 to 316 mm. were examined; thirteen (twelve BLBG, 150.5-209 mm., and one UF 5559, 166.5 mm.) from

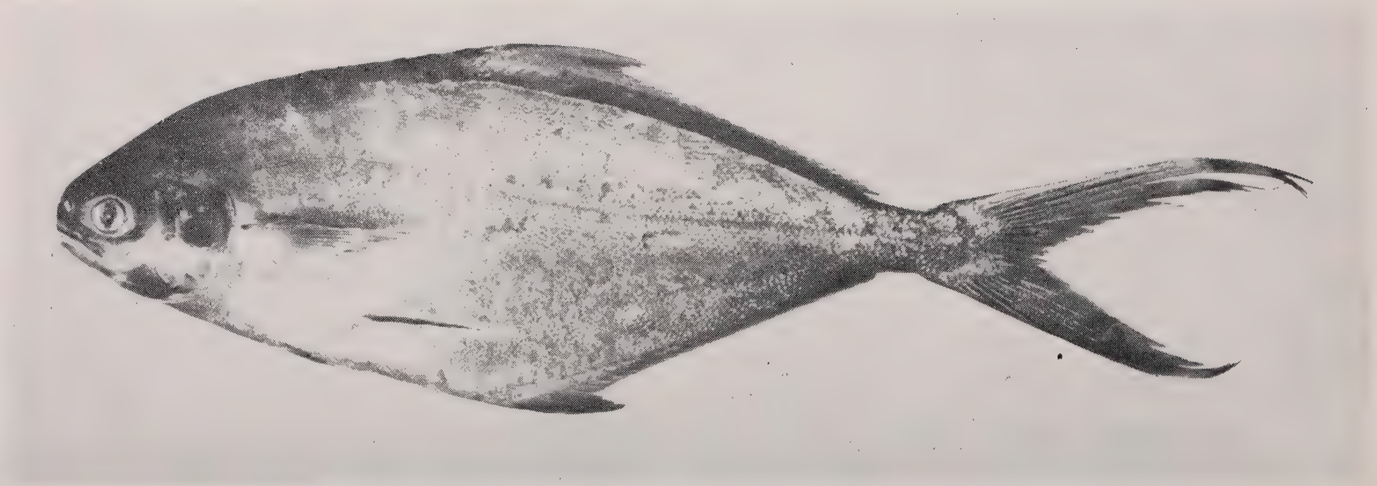

Figure 1.—*Trachinotus cayennensis* Cuvier, CNHM 64522-1, 306 mm. standard length.

off the coast of Brunswick, Georgia; two (BLBG, 262 and 316 mm.), from Fort Walton Beach, Florida; and one (UF uncatalogued, 283 mm.) from Kingston Harbour, Jamaica, British West Indies.

DESCRIPTION OF THE SPECIES

Trachinotus cayennensis

Figure 1

One *T. cayennensis* has five dorsal spines; the remainder have six. Two have 26 dorsal soft-rays, one has 27, two have 28, and one has 29. One has 23 anal soft-rays; the remainder have 27. Meristic and morphometric ranges are given in Table 1.

These color notes are from two specimens (in formalin): *Ore.* 2214, 325 mm.—

Head: Dorsal aspect almost black with olivaceous shading above and behind eye. Preopercle and opercle with dark gray shading behind eye, grading into dingy yellow along posterior ventral margin. Branchiostegal region yellow-white. Snout and maxillary dusky.

Body: Back above lateral line gray-black from caudal base onto head, grading into yellow along lateral line. Belly and sides below lateral line yellow to yellow-white.

Soft dorsal: Light gray background with the leading edge, lobe tip, and ray-tips dusky.

Soft anal: Yellow-gray background on lobe; yellow on remainder. Leading edge, tip of lobe and ray-tips gray-black.

Caudal: Dusky-yellow with darker shadings along its perimeter and on the lobe tips.

Pectorals: Inner side gray-black at base and along first 9-10 soft-rays; remainder of rays white. Outer side dingy-yellow along base and onto first 5-6 rays. Leading edge of fin and tips of first 12 rays gray-black; remainder of tips white.

Pelvics: Creamy yellow.

Ore. 2225, 199 mm.—Similar to *Ore.* 2214 except for lack of yellow cast. The other specimens bear similar coloration, with the larger ones (299 and 306 mm.) possessing the yellow cast.

Trachinotus carolinus

Figure 2

Ginsburg (1952: 81, tables X and XI) examined 346 specimens of *T. carolinus* and reported that 51 had a dorsal spine count of 6

(V-I) while the remainder had 7 (VI-I). The range of dorsal soft-rays for 342 specimens was 23-27; 36 had 23 rays, 183 had 24, 110 had 25, 12 had 26 and one had 27. The maximum number of anal soft-rays for 346 specimens was 23; four specimens had 20 rays, 127 had 21, 188 had 22 and 27 had 23.[3] Of 16 *T. carolinus* I examined, two have 6 dorsal spines and the remainder have 7. Two have 23 dorsal soft-rays; eight have 24, four have 25, and two have 26. Two have 20 anal soft-rays; seven have 21; six have 22; and one has 23. Meristic and morphometric values are presented in Table 1.

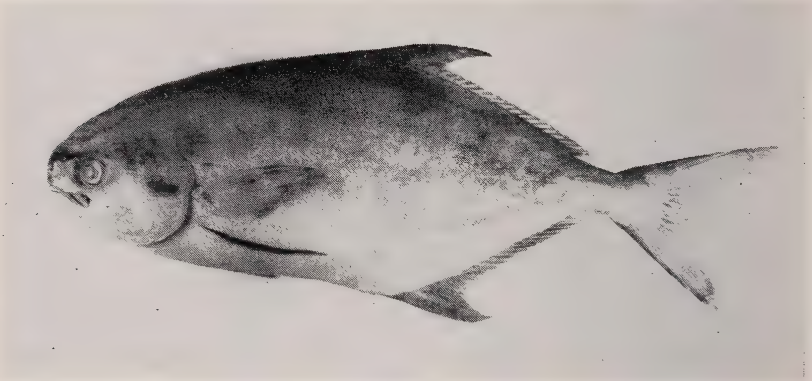

Figure 2.—*Trachinotus carolinus* (Linnaeus), BLBG uncatalogued. 316 mm. standard length.

Trachinotus paitensis
Figure 3

The only specimen of *T. paitensis* I examined is one described and illustrated in Evermann and Radcliffe (1917: 62 and Pl. 6, fig. 1) as *T. paloma* Jordan and Starks, and in Hildebrand (1946: 216, fig. 48). My count of dorsal soft-rays is one more than that of Evermann and Radcliffe.

I find no information in the literature on the relationship of total length to standard length for *T. paitensis*. Therefore I rely on data given by Hildebrand (1941: 216): "The Mission furnished nine specimens, 75 to 270 mm. (57 to 197 mm. to base of caudal)

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[3] *Trachinotus carolinus* (= *Gasterosteus carolinus* Linnaeus 1766: 490) was depicted as having an anal soft-ray formula of 27. However, Goode and Bean (1885: 203) stated that the holotype had 23 anal rays.

TABLE 1.—RANGES OF MERISTICS AND PROPORTIONAL MEASUREMENTS OF *T. CAYENNENSIS*, *T. CAROLINUS*, AND *T. PAITENSIS*. (THE SUPPLEMENTARY DATA ON *T. PAITENSIS* ARE FROM HILDEBRAND, 1946, pp. 215-216.)

	T. cayennensis (6 specimens) 193-325 mm. Standard Length		*T. carolinus* (16 specimens) 150.5-316 mm. Standard Length		*T. paitensis* (1 specimen) 285 mm. Standard Length		*T. paitensis* (10 specimens from Hildebrand) 57-285 mm. Standard Length	
Dorsal rays	IV to V-I, 26 to 29		V to VI-I, 23 to 26		VI-I, 26		VI-I, 24 to 27	
Anal rays	II-I, 23 to 27		II-I, 20 to 23		II-I, 23		II-I, 22 to 25	
Gill-rakers	6 to 7 + 13 to 15		2 to 6 + 7 to 10		4 + 11		3 to 4 + 8 to 10	
	In Standard Length	% of Standard Length	In Standard Length	% of Standard Length	In Standard Length	% of Standard Length	In Standard Length	% of Standard Length
Total length	0.6- 0.7	140.2-154.3	0.7- 0.8	126.9-134.9	—	—	0.7-0.8*	131.6-137.1*
Depth	2.3- 2.7	37.3- 42.7	2.0- 2.5	39.7- 50.3	2.6	38.8	2.2-2.5	—
Snout to first dorsal spine	2.4- 2.8	36.3- 41.7	2.2- 2.5	40.2- 45.8	2.6	39.1	—	—
Snout to first anal spine	2.0- 2.3	44.1- 50.3	1.7- 1.9	52.8- 59.8	2.0	50.5	—	—
Head length	4.1- 5.0	20.1- 24.7	3.5- 4.0	24.8- 28.8	4.3	23.2	3.5-4.25	—
Eye diameter	12.8-19.6	5.1- 7.8	12.5-17.8	5.6- 8.0	17.5	5.7	—	—
Dorsal base length	1.7- 1.8	56.2- 57.8	1.7- 1.9	53.8- 57.9	1.7	58.9	—	—
Anal base length	2.0- 2.2	45.6- 49.7	2.4- 2.7	37.3- 42.0	2.3	44.0	—	—
Dorsal lobe length	3.9- 5.2	19.4- 25.5	3.3- 4.2	23.8- 30.7	4.6	21.9	—	—
Anal lobe length	4.8- 5.5	18.3- 21.0	3.6- 4.3	23.1- 28.1	—	—	—	—
Caudal lobe length	1.8- 2.1	47.0- 56.9	2.3- 2.9	34.0- 43.7	—	—	—	—
Pectoral length	4.4- 5.4	18.6- 22.7	3.9- 4.8	20.7- 25.8	5.1	19.5	4.2-5.4	—
Pelvic length	10.0-13.9	7.2- 10.0	6.8- 9.7	10.3- 14.8	9.4	10.6	—	—
	In Head Length	% of Head Length	In Head Length	% of Head Length	In Head Length	% of Head Length	In Head Length	% of Head Length
Snout length	4.5- 6.1	16.4- 22.1	4.4- 6.3	15.9- 22.7	4.6	21.7	3.8-4.3	—
Eye diameter	3.2- 4.0	25.2- 31.7	3.6- 4.5	22.2- 27.9	4.0	24.7	3.7-5.6	—

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* The determination of these data is explained on page 36.

long . . ." He also alludes to USNM 77686 by stating, "The large specimen secured by R. E. Coker, which was reported to be 380 mm. long (caudal now broken) . . ."

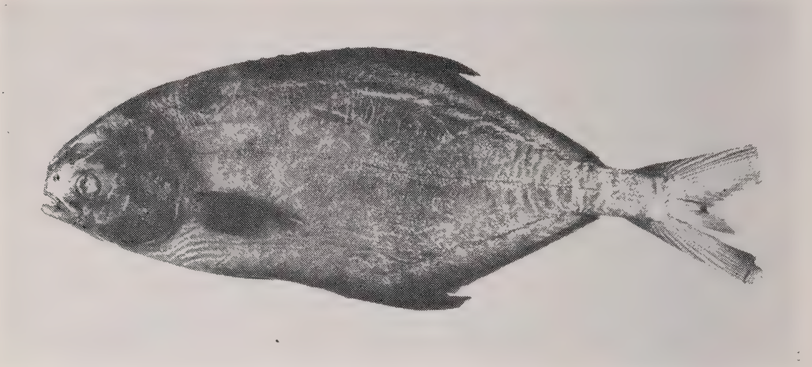

Figure 3.—*Trachinotus paitensis* Cuvier, USNM 77686, 285 mm. standard length.

With this information, and assuming that the minimum total length and the minimum standard length apply to the same fish and that the same is true for the maximum lengths, and by using the total and standard lengths for USNM 77686, limited ranges of proportions and percentages of total length to standard length for *T. paitensis* were determined and are included with Hildebrand's data in Table 1.

COMPARISONS

Table 1 shows that *T. cayennensis* differs from *T. carolinus* in the following characters: *T. cayennensis* possesses 5 or 6 dorsal spines (usually 6), 26 to 29 dorsal soft-rays and 23 to 27 anal soft-rays. *T. carolinus* possesses 6 or 7 dorsal spines (usually 7), 23 to 26 dorsal soft-rays and 20 to 23 anal soft-rays. *T. cayennensis* also has a higher gill-raker complement; proportionally greater total length, anal base length, and caudal lobe length; averages shallower depth, shorter snout to first dorsal spine distance, eye diameter, dorsal lobe length and pectoral length; and has considerably shorter head length, anal lobe length, pelvic length, and distance from snout to first anal spine.

T. cayennensis differs from *T. paitensis* in having a lower dorsal spine complement (*T. paitensis* has 7 spines), averaging higher dorsal and anal soft-ray formulae (*T. paitensis* has 24 to 27 dorsal and 22 to 25 anal soft-rays), and having a much higher gill-raker complement. *T. cayennensis* also has proportionally greater total length, slightly greater anal base length and shorter pelvic length (Table 1).

T. cayennensis (193 to 325 mm.) shows considerably more dental development than *T. carolinus* and *T. paitensis*. Teeth are present on premaxillaries, mandible, vomer, and palatines of all *T. cayennensis*, and there are no teeth on the tongue. The smallest *T. carolinus* (150.5 mm.) has teeth on premaxillaries and mandible only; three of the four next larger *T. carolinus* (157-165.5 mm.) have teeth on the mandible only; and all larger specimens are toothless. *T. paitensis* (285 mm.) has teeth on the mandible only.

ACKNOWLEDGMENTS

I wish to acknowledge the generous assistance of the following individuals: Harvey R. Bullis, U. S. Fish and Wildlife Service, provided the *T. cayennensis* that initiated this study; Leonard P. Schultz made available U. S. National Museum materials; Loren P. Woods furnished Chicago Natural History Museum specimens; David K. Caldwell, U. S. Fish and Wildlife Service, supplied University of Florida material and offered many helpful suggestions in the preparation of the manuscript; Frederick H. Berry, U. S. Fish and Wildlife Service, obtained the material in the Biological Laboratory, Brunswick, Georgia, collectons, and gave much constructive advice; William W. Anderson and Jack W. Gehringer, U. S. Fish and Wildlife Service, offered many helpful suggestions and critically reviewed the manuscript.

LITERATURE CITED

BAILEY, REEVE M.

1951. The authorship of names proposed in Cuvier and Valenciennes' "Histoire Naturelle des Poissons." *Copeia,* 1951 (3): 249-251.

CUVIER, G., and A. VALENCIENNES

1831. *Histoire Naturelle des Poissons.* Paris: F. G. Levrault, 8: iv + 470, 36 pls.

EVERMANN, BARTON WARREN, and LEWIS RADCLIFFE

1917. The fishes of the west coast of Peru and the Titicaca Basin. *Bull. U. S. Natl. Mus.,* 95: xi + 166, 14 pls.

GINSBURG, ISAAC

1952. Fishes of the family Carangidae of the northern Gulf of Mexico and three related species. *Pub. Inst. Mar. Sci., Univ. Texas,* 2(2): 47-117, 7 pls.

GOODE, GEORGE BROWN and TARLETON H. BEAN

1885. On the American fishes in the Linnaean collection. *Proc. U. S. Natl. Mus.,* 8: 193-208.

HILDEBRAND, SAMUEL F.

1946. A descriptive catalog of the shore fishes of Peru. *Bull. U. S. Natl. Mus.,* 189: xi + 530 pp., 95 figs.

JORDAN, DAVID STARR

1886. Notes on typical specimens of fishes described by Cuvier and Valenciennes and preserved in the Musée d'Histoire Naturelle in Paris. *Proc. U. S. Natl. Mus.,* 9: 525-546.

LINNEAUS, CARL von

1766. *Systema Naturae.* Editio duo decima, Stockholm: Laurentii Salvii, Vol. 1, pt. 1, 532 pp.

MEEK, SETH E., and DAVID K. GOSS

1885. A review of the American species of the genus *Trachynotus.* *Proc. Acad. Nat. Sci. Phila.* (for 1884), 36: 121-129.

ACADEMIC SUCCESS IN COLLEGE: I. HIGH SCHOOL PREPARATION

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College preparatory programs are available in large high schools. These are seldom rigid and probably never mandatory, but are urged on students who plan to attend college. In almost all Florida high schools, it is possible to select a series of courses which conform reasonably well to such programs. In all our high schools, the student may also take a variety of non-academic subjects which are not included in college preparatory programs.

Opinions, casual and printed, may be found on every side of the many faceted question of the importance for college success of the high school program. One point of view insists that a rigorous college preparatory program is essential; another cites studies purporting to show that what is taken in high school has no bearing on success in college.

The issue is complicated by the fact that success in college is importantly determined by the standards of the institution attended. In its annual report for 1951-52, the Educational Testing Service states:

> Somewhere in this country there is a college for every high school graduate—regardless of his promise, or lack of it, along traditional academic lines, and regardless of whether his ultimate vocational objective is of the traditional academic variety or not—provided only that he has the tenacity to find it and the means to attend it.[1]

Consequently, the high school student who has decided to attend college, his parents and his academic counsellors, not only have the problem of selecting an appropriate high school program, but must also select a college or university which is appropriate to the talents and industry of the student and to his academic preparation. In most instances information about the relative difficulty of various institutions is not available and an intelligent choice is extremely difficult. No one could infer the actual variation in standards which exists among colleges from the materials in their catalogs. The present study is intended to provide some pertinent information about one institution, the University of Florda, located in Gainesville, Florida.

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[1] Educational Testing Service, *Annual Report to the Board of Trustees, 1951-52* (Princeton, New Jersey: The Service), p. 22.

THE STUDY

For the purpose of this study it is assumed that the clearest, most meaningful measure of success in college is the attaining of a degree. Correspondingly, it is assumed that the most unambiguous indication of failure in college is being suspended for academic failure. Within this frame of reference, three groups of Unversity of Florida students were selected for study: (1) All graduates of the College of Arts and Sciences during the calendar year 1956; (2) All graduates of the College of Engineering during the same calendar year; and (3) All students who entered the University as freshmen in September 1952 and who were suspended for academic reasons as rapidly as regulations permitted, viz., at the close of their first year. All three groups therefore, were members of the same generation of students. The first two groups will be referred to as Arts and Sciences and Engineering graduates, respectively, and the third group as the Control group.

The procedure followed in the study was to examine the high school program of courses of each student and to compare the three groups in terms of the number of units earned in each individual academic subject, in all academic subjects and in all non-academic subjects. In addition, the results of the Florida Statewide Twelfth-Grade Testing Program were examined for each student who had taken these tests, and the three groups were compared in terms of average percentile ranks earned in the intelligence examination and in each of the four achievement tests. Also, they were compared in terms of the total of these five percentile ranks. These data were taken directly from the students' permanent record cards in the Office of the Registrar at the University.

The study began as an investigation of the high school preparation of Arts and Sciences graduates only. It was extended to include Engineering graduates in order to examine the foreign language preparation of students graduating from a college which had no foreign language requirement. Finally, the Control group was added to determine whether failure in this University, as contrasted with success, was reflected in the pattern of high school subjects and the results of the State's testing program.

Since the graduates of only two of its colleges are involved, the present results may not be applicable to all University of Florida students. It is clear that these results would apply to students planning degrees in Engineering or Arts and Sciences. This latter group includes those preparing to enter medical school, dental school, theological seminary or law school. In addition, Arts and Sciences degrees represent the undergraduate education of scientists, mathematicians, social scientists, scholars in the humanities, many teachers and a few journalists. The two groups of graduates from Engineering and Arts and Sciences thus include students preparing themselves for many of the learned professions. This study should be of direct value to high school students interested in entering one of these professions and attending the University of Florida.

RESULTS

The results of the analysis of the high school program are given in Table 1.

TABLE 1

NUMBER OF UNITS OF SPECIFIED HIGH SCHOOL SUBJECTS COMPLETED BY THREE GROUPS OF UNIVERSITY OF FLORIDA STUDENTS.

H. S. Subject	182 Graduates of Arts and Sciences		190 Graduates of Engineering		168 Academically Unsuccessful Controls	
	Mean	σ M	Mean	σ M	Mean	σ M
English	3.92	.027	3.93	.022	3.85	.031
Foreign Languages	2.14	.093	1.51	.083	.99	.085
All Social Science	2.61	.050	2.57	.050	2.72	.059
All Mathematics	2.96	.070	3.40	.064	2.23	.085
All Science	2.44	.075	2.85	.060	2.16	.070
History	1.90	.050	1.77	.043	1.96	.055
Physics, Chemistry	1.09	.059	1.47	.047	.63	.057
Algebra, Geometry, Trigonometry	2.70	.059	3.35	.064	2.02	.091
Total Academic	14.03	.147	14.25	.137	11.94	.160
Non-Academic	3.67	.161	3.71	.157	5.61	.191

Inspection of this table and computation of appropriate inferential statistics indicate that the amount of high school work taken in foreign language, mathematics and science distinguishes both Engineering and Arts and Sciences graduates from the academically unsuccessful controls. Engineering graduates earned 7.76 units in these three subjects on the average, Arts and Sciences graduates 7.54 units, and the controls 5.38 units. Each of the groups of graduates, therefore, averaged more than two years additional work in these subjects as compared to the Control group.

If we look at foreign language, mathematics, and science separately, we find that each of the groups of graduates had significantly more work than did the controls in each of these three subjects. (Five of the six differences are significant at the .1% level of confidence and the other at the 1% level). A comparison of the Arts and Sciences and Engineering graduates with each other shows, as might be expected, that the Arts and Sciences group had more foreign language[2] ($t = 5.08$, $P < .001$), less mathematics ($t = 4.63$, $P < .001$) and less science ($t = 4.27$, $P < .001$). None of the above results were importantly affected by limiting the science category to chemistry and physics or limiting the mathematics category to algebra, geometry, and trigonometry.

In general, the amount of English and social science taken in high school is much the same for all students and in this study does not clearly differentiate these three groups. The difference of .08 units in English in favor of the Engineering graduates over the Control group is of borderline statistical significance ($t = 2.11$, $P < .05$). When history is examined separately, it is found that the controls have taken significantly more than the Engineering graduates ($t = 2.71$, $P < .01$). Also, the amount of history taken by Arts and Sciences graduates over that taken by Engineering graduates has a borderline statistical significance ($t = 1.97$, $P < .05$).

The total number of academic as compared with non-academic[3] units sharply differentiates between the two groups of graduates and the controls. Both Arts and Sciences and Engineering graduates averaged over 14 academic units and the control less than twelve. Conversely, the controls averaged almost two non-academic units more than the successful graduates. These differences are all significant at least at the .1% level of confidence. No significant differences in the number of academic or non-academic units were found between the Arts and Sciences and Engineering graduates.

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[2] A different analysis of the foreign language taken by these groups shows that 80.2% of Arts and Sciences graduates had two years or more foreign language in high school, as compared with 63.7% of the Engineering graduates and 41.1% of the controls.

[3] Listed on the student's record as "agricultural", "commercial", "vocational" or "others".

A summary of the analysis of the scores from the Florida Statewide Twelfth-Grade Testing Program (widely referred to as the "Senior Tests" in Florida high schools) is given in Table 2.

TABLE 2

PERCENTILE RANKS ON THE FLORIDA STATE-WIDE TWELFTH-GRADE TESTING PROGRAM FOR THREE GROUPS OF UNIVERSITY OF FLORIDA STUDENTS.

Test*	130 Graduates of Arts and Sciences		158 Graduates of Engineering		159 Academically Unsuccessful Controls	
	Mean	σ M	Mean	σ M	Mean	σ M
ACE Psychological	79.9	1.43	76.1	1.81	43.4	1.93
Coop. English	82.0	1.58	73.2	1.78	44.0	1.98
Social Studies	82.4	1.36	80.3	1.31	45.8	1.97
Natural Sciences	82.7	1.39	85.5	1.38	51.2	2.16
Mathematics	81.7	1.43	85.5	1.61	51.4	1.91
Total % rank	408.5	5.85	401.0	6.46	236.0	8.04

* The tests in this program are prepared by the Cooperative Test Division of the Educational Testing Service of Princeton, New Jersey. They are, in order, the American Council on Education Psychological Examination for High School Students, the Cooperative English Effectiveness of Expression Test, and the battery of three Cooperative General Achievement Tests: I. Social Studies, II. Natural Sciences, III. Mathematics. The percentile rank indicates the percentage of all graduates of white Florida high schools whose test score was equal to or lower than the individual's test score. The total percentile rank merely indicates the total of the five percentile ranks for one individual.

The differences in these results between both the Arts and Sciences and Engineering graduates as compared with the Control group are striking. For the aptitude test and each of four achievement tests, these differences are of the order of magnitude of 35 percentile ranks ($t > 10.$ and $P < .001$ for each of these ten differences). The Control group averaged 236 for the total of the five percentile ranks as compared to over 400 for each of the two groups of graduates. In other words, the Control group on these tests, as a group, were at the middle of the State's population of high school graduates; while the two groups of successful college graduates made higher average scores on the Senior Tests than do 80% of high school graduates.

Only one difference in these scores between the Arts and Sciences and Engineering graduates was found to be statistically significant, viz., the difference of 8.8 percentile ranks in English achievement in favor of the Arts and Sciences group ($t = 3.70$, $P < .001$).

COMMENT

The results of this study may be generalized as follows:

1. More units of foreign language, mathematics and science are taken in high school by students who later graduate in Arts and Sciences and Engineering at the University of Florida than are taken by those who are dropped for failure at the end of their freshman year at this University.
2. More academic units and fewer non-academic units are taken in high school by those who later graduate as compared with the academically unsuccessful group of controls.
3. The number of high school units of English and social science does not differentiate between the successful graduates studied and the controls.
4. The intelligence level of the successful graduates is superior to that of the Control group.
5. The adequacy of high school preparation of the successful graduates as measured by achievement tests in English, natural science, social science, and mathematics is superior to that of the Control group.

Some will conclude from these statements that the differences found in the high school programs occurred *merely* because the more intelligent students tend to take the harder academic subjects; and, because they are the more intelligent, they are also the ones who, later, are successful in college. Most of us who work with the academic problems of university students on a day-to-day basis reject this as an over-simplified, overworked justification of a non-academic emphasis in the high school programs of too many students who later fail at academically substantial colleges and universities.

It is obvious that this factor of intelligence is of primary importance in both the selection of difficult high school courses and the successful completion of college. It should not, however, be used as the whole explanation for all college success or failure, completely ignoring another general factor, motivation, and such specific considerations as the direct results of previous schooling. The development of a strong higher-order motivational pattern "to achieve an education" is of great importance to success in college. President Reitz of the University of Florida once stated, "Occasionally some of the high-ranking students fail in college, but such failures are probably due to a lack of interest or motivation or both."[4] In most instances the motivational pattern which underlies academic success in college probably depends on home background or the influence of an inspiring teacher.

In addition to these general considerations of intelligence and motivation, the experienced academic advisor would urge the importance of the difficult, college preparatory high school courses as directly and intrinsically contributing to college success for three reasons:

First, university courses are a great deal more difficult than are high school courses. The most difficult high school courses provide the best practice for the level of difficulty of academic work required in an institution such as the University of Florida.

Second, the more difficult high school courses are similar in content to the general courses required in most university curricula, and what is learned in them will provide necessary foundation for, or apply directly to, the successful completion of the college courses.

Third, advanced high school courses in language and mathematics will develop and sharpen the student's facility in working with words and numbers. Failure in college is very often the immediate result of inadequate verbal and/or numerical skills.

For the purpose of assisting a high school counsellor or parent in deciding whether a student should select the University of Florida for an Engineering or Arts and Sciences degree, the results of this study provide the basis for a brief description of the academic and intellectual features to be found in the high school graduation portrait of the typical student who will successfully complete such degrees.

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[4] Reitz, J. Wayne, Should You Enter College? *All Florida Weekly Magazine,* August 3, 1957.

This average future University graduate has taken 14 or more high school units in academic courses, over seven and one-half of which are in foreign language, mathematics and science. He has almost four units of English and over two and one-half units of social science. He has taken less than four high school units in non-academic subjects. He exceeds more than three-fourths of his fellow high school graduates in intelligence, and has achieved in high school a greater knowledge of English, mathematics, social studies and science than about 80% of his high school classmates. The total of his five percentile ranks in the Senior Tests is above 400, although if we define him as the middle half of the successful graduates studied, this total score ranges approximately from 370 to 460. Finally, although it cannot be demonstrated from the statistics of this study, it is certain that he has, or is capable of quickly developing, the maturity to work consistently and hard at his University courses.

A PLEISTOCENE *TERRAPENE* HIBERNACULUM, WITH REMARKS ON A SECOND COMPLETE BOX TURTLE SKULL FROM FLORIDA

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Very recently (1958) I published a study on the Pleistocene box turtles of Florida. Of the localities from which remains of these turtles were available, Reddick I B, Marion County, was truly outstanding in providing such large numbers of specimens. Many individuals are represented by complete shells. The concentration of so many individuals of one species in one locality, when fragments are only reasonably common in others, is most unusual.

The fairly large number of articulated shells, many with associated limb and girdle elements, or even fragmentary or complete skulls, seems to rule out predation by some carnivore. The turtles seem to have died in place, or nearly so. The assemblage appears to be a natural one. Individuals of all sizes are represented in the material at hand. Male and female specimens are found in almost equal numbers. Most curious is the fact that all of the specimens are found in a single bed no thicker than two feet. Only a few fragments of this species are found above and below this bed. Included in the *Terrapene* stratum, but apparently much more abundant above and below it, are numerous fragmentary remains of *Testudo, Gopherus, Ursus, Canis, Felis* and *Paramylodon.* Most of the snakes and lizards collected from Reddick I B originated from the *Terrapene* stratum. Normally the scattered remains of fairly large numbers of many different species of animals would suggest that their bones accumulated over a long period of time. In no other known locality in Florida are so may *Terrapene* bones restricted to such a narrow zone. It seems highly unlikely that the bed simply represents a period during which the box turtle was extremely common in the area. Rather, it appears that the turtles accumulated in the cavern or fissure during a reasonably short period of time.

Based on a number of well documented facts it is obvious that the beds in the entire exposure represent an ancient cave filling.

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[1] A contribution from the Department of Biology and the Florida State Museum, University of Florida.

Thus the box turtles could have fallen into an opening in the cavern roof, as most of the other vertebrates might have done. However, this implies the unreasonable conclusion that many more *Terrapene* fell into the cave during a short period of time than almost all of the other turtles and mammals did over a much longer period of time. On the other hand, the *Terrapene* might have crawled into the cave or fissure over a short length of time. However, the problem then presents itself as to how or why the turtles died there. Without additional elaboration of the hypothesis it also fails to explain by *Gopherus* and *Testudo* are so common above and below this bed, but represented by only occasional fragments within it.

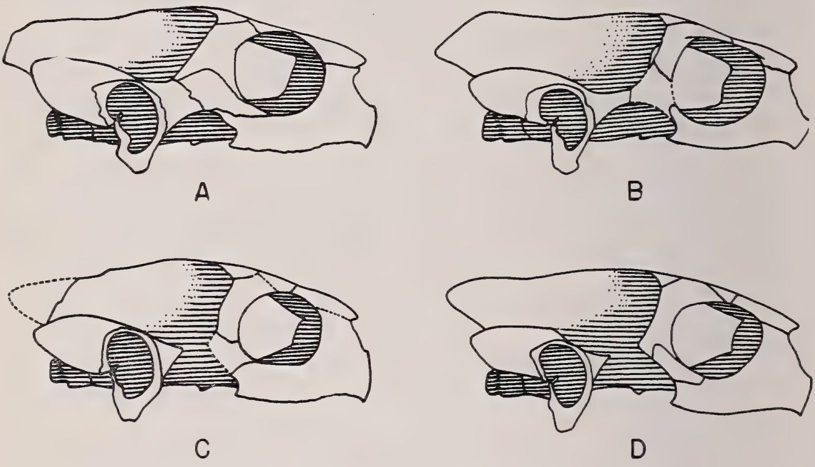

Figure 1. Lateral views, skulls of Recent and Pleistocene box turtles, *Terrapene carolina.* A. *T. c. major,* Recent. B. UF 2913, Pleistocene, Reddick I B, *T. c. carolina* X *T. c. putnami.* C. UF 9973, Pleistocene, Arredondo I C, *T. c. carolina.* D. *T. c. carolina,* Recent.

Box turtles are known to congregate in hibernacula during the winter months in some more northern areas (Carpenter, 1957). As far as is known they do not congregate in any numbers in Florida during the winter or summer months at the present time. If the stratum at Reddick I B represents a winter season, in which hibernating box turtles secreted themselves during cooler weather it would explain the near absence of articulated *Gopherus* and *Testudo* in the same bed, since at least the former is known to spend the winter months at the bottom of its burrow. However, during the warmer months *Gopherus* is quite active, and might easily fall into small fissures. At least *Gopherus* and *Testudo* are poorly adapted to crawling up out of steep depressions. *Terrapene* seems fairly accomplished in this ability. If these turtles entered the fissure regularly during the cooler months for refuge, it is assumed that they could manage to get back out. This might explain their near absence in the beds above and below the *Terrapene* stratum in which *Gopherus* and *Testudo* are found.

The presence of a hibernaculum as seems to be represented at Reddick suggests much cooler conditions than are found in the peninsula at the present time. Brodkorb (1957) has suggested that the Reddick deposits represent Illinoian maximum. I have recently indicated (1958) that these deposits do not, in all probability, represent the maximum extent of the glacier, but some undetermined time slightly before or after this time. In any event, conditions near, or at Illinoian maximum were certainly cooler than at present. Several vertebrates from the deposit are presently found only to the north of Florida (Auffenberg, 1956; Brodkorb, 1957; Olsen, 1958).

On the basis of the discussion of possibilities above it is suggested that the narrow, light-colored *Terrapene* bed (and probably others) at Reddick I B represents an accumulation during the winter months. The more organic layers immediately above and below this stratum may represent deposition during warmer months. This then assumes that accreation occurred at a rate of about one foot per season for the three seasons considered. Perhaps this is more than can reasonably be accounted for during such a short period of time. However, deposition below, or very near an opening in a cavern can be expected to be quite rapid, especially with heavy rainfall, as has been postulated for glacial times in southeastern United States (Odom, 1952). Whether or not these beds represent different seasons can probably be proven only by a detailed comparative study of the avian fossils from the different strata. Migrant species might be present in one bed, and not in the other, etc.

The presence of so many individuals in the *Terrapene* layer indicates that some catastrophic event must have taken place during the cooler months. There are two main possibilities: the opening to the surface was accidentally filled in by debris so that the animals were effectively trapped and could not reach the surface, or the site, of adequate protection for a normal near-Illinoian winter, was insufficient for at least one year. In either event, the slight movement of individuals down the slope since their death can be most easily attributed to slumping during some post depositional phase of cavern filling. The reasonably complete nature of the turtles and the remaining vertebrates clearly indicate that the beds were formed close to the surface and to the opening of the fissure, or small cave.

In the recent publication previously mentioned (Auffenberg, 1958) I described the only complete Pleistocene *Terrapene* skull then known in Florida. This skull (UF 9973),[2] from Arredondo I C, Alachua County, was associated with a fine shell. Both the shell and skull show close affinities with *Terrapene c. carolina,* a form now found north of peninsular Florida. Only a partial skull was available from the important locality at Reddick I B, Marion County. Unfortunately, certain important diagnostic morphological features were missing from this specimen. On the basis of a reasonably large sample of complete shells from the same locality, the specimens were referred to *T. c. carolina* X *T. c. putnami.* A complete specimen of box turtle from the same locality has recently been found (UF 2913). The individual apparently died after closing its shell. As a result, the entire skeleton is intact. The skull lacks only the jugal. It indicates that the previous reconstruction of missing parts on UF 9933 from the same locality is slightly incorrect. A postorbital bar is present, but the quadratojugal is narrower than previously supposed. The jugal, though missing, is definitely large, and presumably more or less triangular in side view. The postorbital is considerably narrower than in *Terrapene c. major,* and only slightly narrower than in most specimens of *T. c bauri,* much more like that in *T. c. carolina* and *T. c. triunguis.* The squamosal is large, long, unlike that in *triunguis,* but more like that in the other Recent subspecies. The postpalatine foramina are smaller than those in *major,* but larger than those in *bauri, carolina* and *triunguis.* The fronto-nasal area is larger than that in *bauri, carolina* and *triunguis,* but smaller than that in *major.* The temporal ridges are more well developed than in large specimens of *bauri, triunguis* and *carolina,* but not as strongly produced posteriorly as in *major*. Figure 1 illustrates the new skull from Reddick I B.

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[2] University of Florida Collection.

The newer specimen proves what was suspected before—that the skull, as well as the carapace, illustrates many characteristics which are intermediate between those of *T. c. major* and the remaining living subspecies. In the previous publication *T. c. major* was interpreted as a relict intergrade population between *T. c. carolina* and the larger extinct Pleistocene form, *T. c. putnami*. The latter differs from *T. c. major* only in being larger, as far as is known. The Pleistocene Reddick I B population is considerably larger than Recent populations of *T. c. bauri, triunguis* or *carolina*. Thus this population is thought to be an intergradient one between *T. c. carolina* (or *bauri* ?) and *T. c. putnami*. A complete skull of the latter has not yet been found. It is to be hoped that in the near future a skull of this interesting extinct form will become available for study.

Literature Cited

AUFFENBERG, W.

1956. Additional records of Pleistocene lizards from Florida. *Quart. Journ. Fla. Acad. Sci.,* 19(2-3): 157-167.

1958. Fossil turtles of the genus *Terrapene* in Florida. *Bull. Fla. State Mus., Biol. Sci.,* 3(2): 53-92.

BRODKORB, P.

1957. New passerine birds from the Pleistocene of Reddick, Florida. *Journ. Paleontol.,* 31(1): 129-138.

CARPENTER, C. C.

1957. Hibernation, hibernacula and associated behavior of the three-toed box turtle *(Terrapene c. triunguis)*. *Abstract, Annual meetings, Amer. Soc. Ichthyologists and Herpetologists,* New Orleans, 1957.

ODOM, H. T.

1952. The Carolina Bays and a Pleistocene weather map. *Amer. Journ. Sci.,* 250: 263-270.

OLSEN, S. J.

1958. The bog lemming from the Pleistocene of Florida. *Journn. Mammal,* 39(4): 537-540.

COMPARISON OF THE TERATOGENIC EFFECTS OF TRYPAN BLUE AND LOW TEMPERATURE IN THE MEDAKA FISH *(ORYZIAS LATIPES)*[1]

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The teratogenic activity of the azo dye trypan blue is well established in such animals as the rat, mouse, rabbit, and hamster. The experimental procedure for these forms has usually involved an injection of the dye into the maternal organism during the early stages of pregnancy. Earlier investigators have suggested that the dye produced a change in the maternal metabolism which secondarily affected the embryo or that caused some alteration of placental permeability. However, Ferm (1956) found that in the rabbit trypan blue is demonstrable in the blastocyst fluid after maternal injection on days 7, 8 or 9 of gestation and concluded that the teratogenicity of the dye was due to a direct toxic effect on the embryo. Further evidence for the direct action of trypan blue on the embryo was recently presented by Beaudoin and Wilson (1958) as the result of a series of experiments on the developing chick. Waddington and Perry (1956) claimed a direct teratogenic effect on amphibian embryos but no control animals were referred to in their report. Ingalls, in a popular article (1957), stated that the dye is an effective teratogenic agent upon the developing eggs of the zebra fish (*Brachydanio rerio*) and suggested that the mechanism consists of a reduction in respiratory rate of dividing cells, but no information was given about the experiments which led to these conclusions. No unequivocal evidence of teratogenic action of this dye in a poikilothermic vertebrate has been presented.

The earliest experimental production of abnormalities in fish embryos was that reported by Lereboullet (1864). In one portion of his work he exposed developing European pike *(Esox)* eggs to cold and alternating temperatures (degree and duration not indicated) and reported that this had no effect upon the usual rate of

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[1] This investigation was supported by a research grant to the Department of Anatomy, College of Medicine at the University of Florida from the Easter Seal Foundation of the National Society for Crippled Children and Adults.

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structural abnormality in that species. The next experiment of this type was performed some 50 years later when Jacques Loeb (1915), in attempting to discover the reason why some cave-dwelling fishes possess defective eyes, exposed the eggs of *Fundulus heteroclitus* to unusually low temperatures. He found that when the eggs were newly fertilized or in early cleavage stages, a reduction of the temperature to 0° to 2°C. resulted in the appearance of a "considerable" number of abnormal individuals, many of them possessing eye defects. However, when the temperature was allowed to rise to 7°C. or when embryos of 128 cells or later stages were utilized, the abnormalities did not occur. Kellicott (1916) found that newly fertilized eggs or those in early developmental stages when subjected to temperatures of 8° to 10°C. for a few hours or days either died or developed abnormally. He noted that the circulatory system and the eyes were especially prone to anomaly.

Stockard (1921) subjected 2 to 16 cell cleavage stages of *Fundulus heteroclitus* to 5° to 8°C. for 48 to 69 hours and obtained large numbers of abnormal individuals, included among them several double monsters. He concluded that a connection of primary importance existed between retardation of development by low temperature or other means and the origin of double specimens. Since *Fundulus* and the medaka are members of the same family (Cyprinodontidae) it was decided to use the latter species to test this and others of Stockard's postulates. He maintained, for example, that the time of treatment was the sole determinant of the teratogenic effect and that the nature of the agent was of little consequence so long as it interfered with growth at some "critical moment."

The purpose of this experiment, then, was to compare the effects of a chemical agent, trypan blue, and a physical agent, low temperature, on the developing medaka egg and to examine the results in the light of previous work using these particular teratogens.

METHODS

Each pair of breeding adults was isolated in a 10 gallon aquarium. A cluster of fertilized eggs was removed from the female each morning shortly after spawning took place, divided into experimental and control groups of approximately equal size, and placed in finger bowls in about 150 cc. of water with about 10 to 20 eggs per finger bowl. These eggs were kept well separated from one another. In the trypan blue experiments both experimental and control groups were removed to small stender dishes of 25 cc. capacity. After exposure to either dye or water the eggs were rinsed and returned to the finger bowls until hatching. The dye used was a specially purified sample of trypan blue.[3] Aqueous solutions were freshly made every two weeks and were kept under refrigeration prior to use. In the low temperature experiments the eggs scheduled for treatment were kept in the original finger bowls and placed in a refrigerator for the desired amount of time.

RESULTS

Trypan Blue Experiment. Following the lead of Waddington and Perry (1956), who claimed a significant result in their amphibian work with a concentration of .025%, the initial experiments were carried out using an aqueous solution of trypan blue of this strength. Thirty-eight lots, comprised of 417 eggs, were exposed to the dye for a period of 24 hours beginning at the 15-hour (embryonic shield) stage with an identical number being kept as a control. The dye produced no discernable effect.

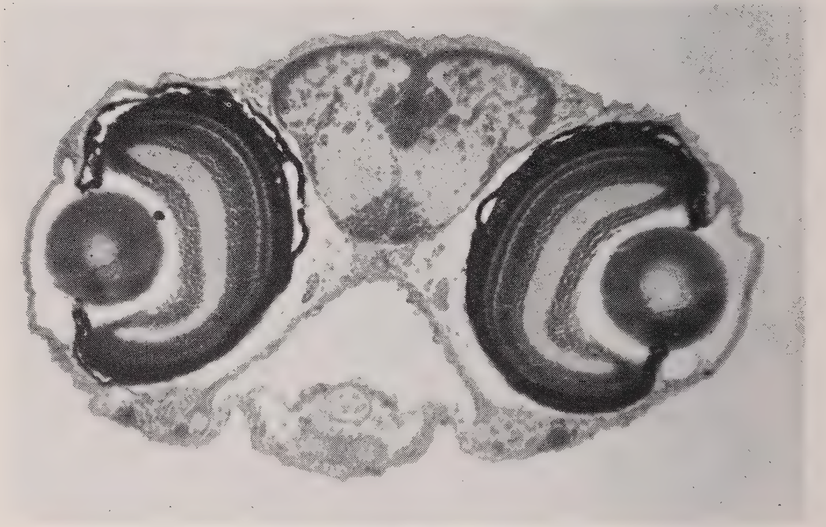

Figure 1.

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[3] Procured from Matheson, Coleman and Bell Company, Norwood, Ohio.

TABLE 1

EXPOSURE TO INCREASING CONCENTRATIONS OF TRYPAN BLUE AT THE SIX HOUR (EARLY BLASTULA) STAGE FOR 24 HOURS.

Concentration %	Total Number	Mortality %	Abnormality %
.025	23	30.4	0
Control	22	22.7	0
.050	13	0	0
Control	13	7.7	0
.1	10	60.0	0
Control	10	50.0	0
.2	18	38.9	0
Control	17	17.6	0
.4	26	42.3	0
Control	26	23.0	0
.8	17	5.9	0
Control	17	0	0
1.25	89	38.2	2.2
Control	88	5.7	0
2.50	90	40.0	6.6
Control	90	15.5	1.1

TABLE 2

EXPOSURE TO THE MAXIMUM CONCENTRATION (2.50%) OF TRYPAN BLUE AT PROGRESSIVELY EARLIER STAGES.

Stage	Exposure Hrs.	Total Number	Mortality %	Abnormality %
4-cell	48	44	100.0	0
Control	none	45	8.9	0
4-cell	24	18	94.4	0
Control	none	17	11.8	0
4-cell	4	45	13.3	0
Control	none	46	10.9	0
4-cell	2	124	35.5	0.8
Control	none	122	2.5	0
4-cell	1	67	61.2	1.5
Control	none	66	15.1	0
2-cell	24	171	98.8	0.6
Control	none	169	1.8	0
2-cell	4	131	88.5	1.5
Control	none	132	4.5	0
2-cell	2	138	78.3	0.7
Control	none	134	6.0	2.2
Zygote	.5	26	100.0	0
Control	none	27	0	0

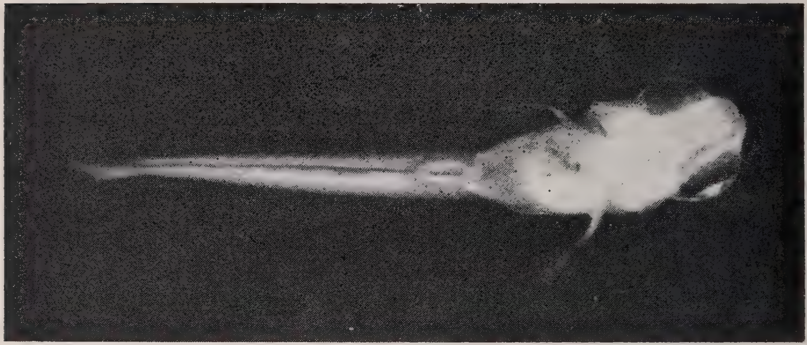


Figure 2.

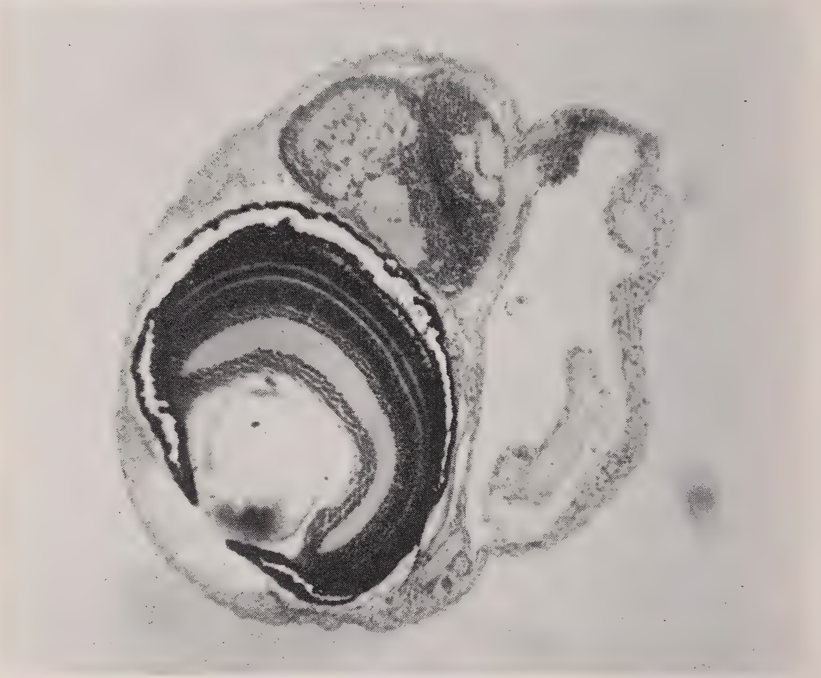


Figure 3.

It was then decided to treat a series of younger embryos at the six-hour (early blastula stage with increasing concentrations of the dye. The results are seen in Table 1. As the concentration increased, mortality in the treated groups exceeded that in the controls, but the rate of malformation still remained very low. Even at the maximal concentration of 2.5%, abnormalities were found in only four lots of the 11 exposed and in only one of these was more than a single-individual affected.

Having ascertained that the majority of the early blastula embryos could survive immersion in a 2.5% solution for several hours, embryos at other stages were exposed to this concentration of dye. Nine lots including 127 eggs were treated for a period of 24 hours beginning at the 25-hour (neural keel) stage, with 122 eggs kept as controls. Mortality was 13.4% and the rate of abnormality 3.9% both considerably lower than was the case with the early blastula embryos. No later stage was treated since the medaka is far advanced in differentiation at 49 hours, the time at which the neural keel lots were removed from the dye.

Finally, a relatively large number of very early embryos was exposed to the maximal dye concentration of 2.5%. These results (Table 2) show a drastic increase in mortality, so much so that in order to obtain any survivors, the period of exposure had to be reduced as younger individuals were treated. The expected increase in numbers of abnormal individuals did not materialize.

Low Temperature Experiment. Seven lots, including 69 eggs, were exposed to 6° to 7°C. for 48 hours at the 25-hour (neural keel) stage, with 71 eggs kept as controls. No abnormalities appeared and the mortality of the treated groups did not exceed that of the controls. Early cleavage stages were then exposed to the same temperature for the same period as follows: 140 eggs at the 2-cell stage, 46 at the 4-cell stage, and 21 at the 8-cell stage, with similar numbers at each stage retained as controls. All of the treated groups suffered a 100% mortality.

To reduce the severity of the treatment for the early cleavage stages, an exposure time of 24 hours was utilized and the temperature kept at 6° to 7°C. Forty-eight lots consisting of 641 eggs were exposed at the 2-cell stage, 5 lots totaling 62 eggs at the 4-cell stage, and 5 lots totaling 69 eggs at the 8-cell stage. The results are tabulated in Table 3. The occurrence of 61 abnormal young in the treated lots, compared to only two in the control lots, leaves little doubt about the teratogenic effectiveness of low-temperature. It seems apparent that the medaka embryo is most sensitive to low temperature effects at the four-cell stage since this group exhibited the highest percentage of abnormality. Also, it is noteworthy that the mortality decreased markedly as treatment was given at later stages, the survival in the 8-cell group being almost three times that of the 2-cell group and that in the neural-keel stage being within normal range. Further reduction of the exposure time to 12 hours but maintaining the temperature at 6° to 7°C. resulted in no abnormalities and a rate of mortality only slightly higher than in controls.

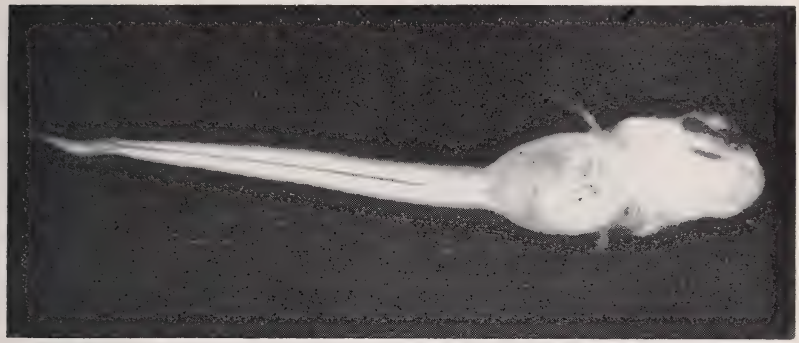
TABLE 3

EXPOSURE OF EARLY CLEAVAGE STAGES TO 6° - 7° C. FOR 24 HOURS.

Stage	Total Number	Mortality %	Abnormality %
2-cell	641	51.9	7.5
Control	639	3.4	0.3
4-cell	62	29.0	12.9
Control	59	8.5	0
8-cell	69	21.7	7.2
Control	71	2.8	0

Additional lots of early cleavage eggs were exposed for 24 hours to 4°C., a lower temperature than had been previously tried (Table 4). Anomalous individuals were again apparent in the treated lots but the incidence was slightly less than that obtained at the 6° to 7°C. level. However, the increased severity of the 4°C. temperature is reflected in the mortality rate which was significantly higher for all three cleavage stages.

Types of Malformations. Too few malformations occurred after trypan blue treatment to permit the establishment of a characteristic pattern of defects. The more prevalent types occurred in both experimental and control groups in almost equal frequency. Among these were general retardation of development and curled body-axis after hatching, with an occasional case of a pug-nosed condition or disproportionately large head. Found only



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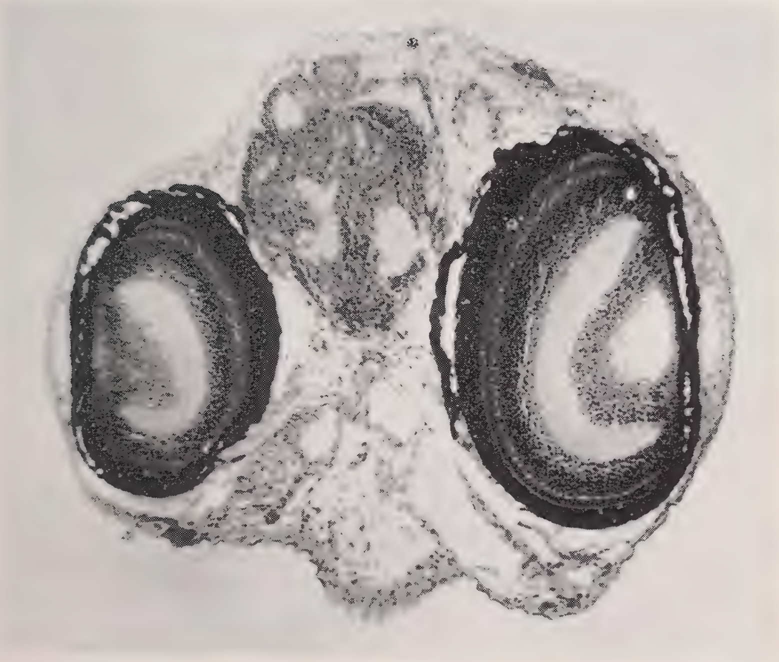

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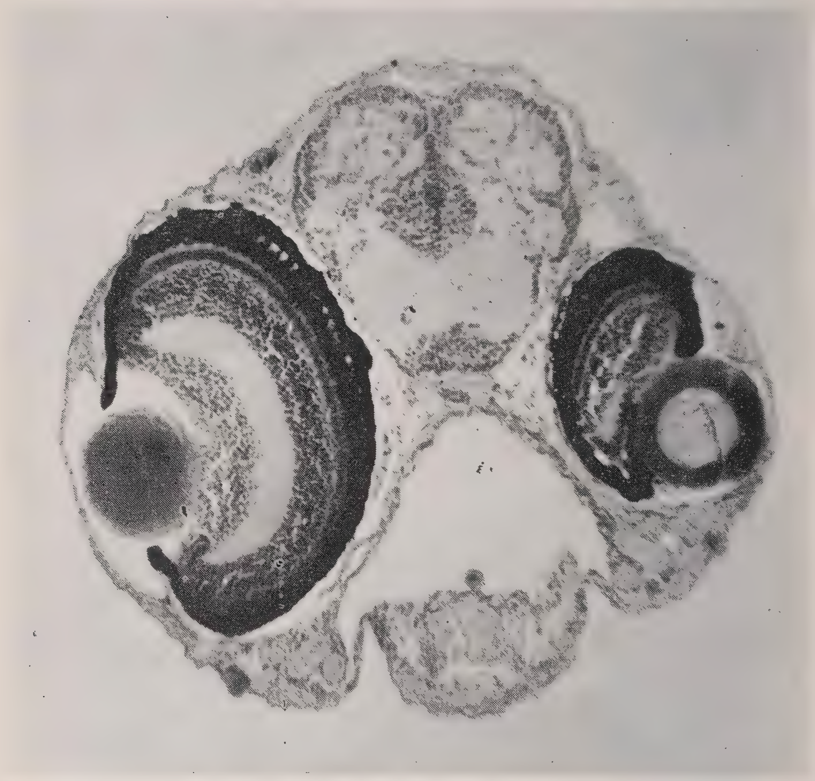


Figure 6.

TABLE 4

EXPOSURE OF EARLY CLEAVAGE STAGES TO 4° C. FOR 24 HOURS.

Stage	Total Number	Mortality %	Abnormality %
2-cell	91	75.8	5.5
Control	89	14.6	0
4-cell	66	89.4	6.1
Control	65	3.1	0
8-cell	38	47.4	7.9
Control	39	0	0

among treated embryos were 4 instances of monophthalmia, one of bilateral microphthalmia and one of complete anophthalmia. Two fishes, one of which also had an eye defect, had conspicuously reduced tail development. Thus, of 1594 treated embryos only 7 had types of developmental abnormalities not observed in equivalent frequency among the controls.

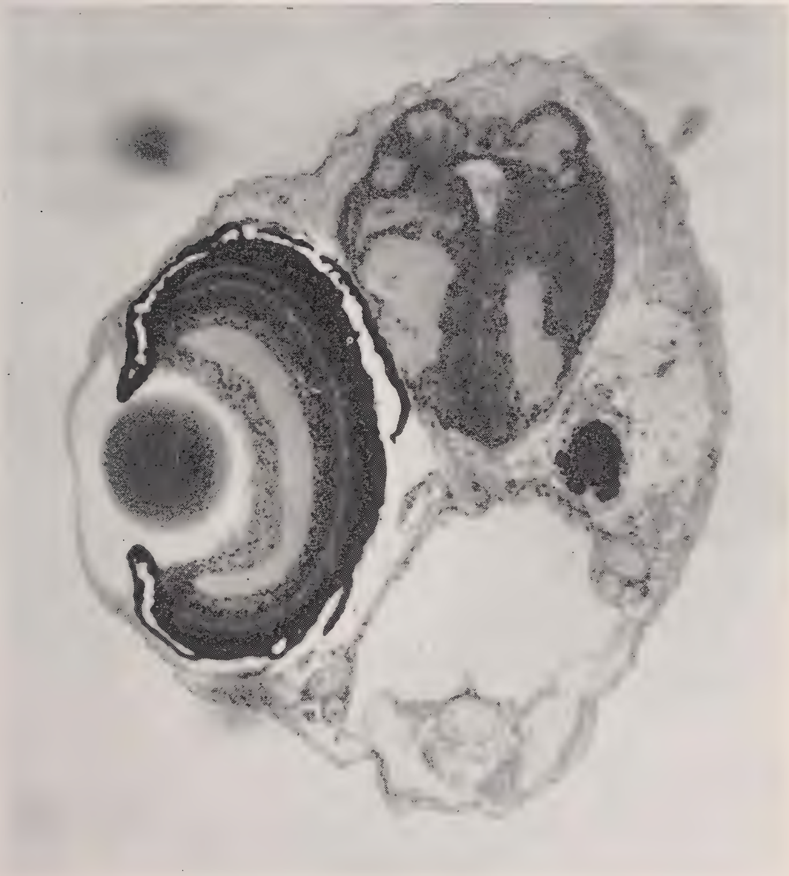
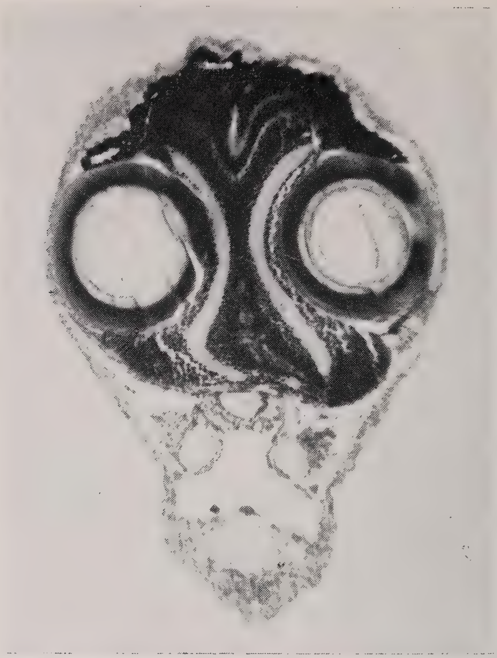


Figure 7.

In the low temperature experiments there was no obvious difference in the type of malformation produced at either of the two temperature levels or among the three cleavage stages. In almost all cases, the most striking result was the relatively large



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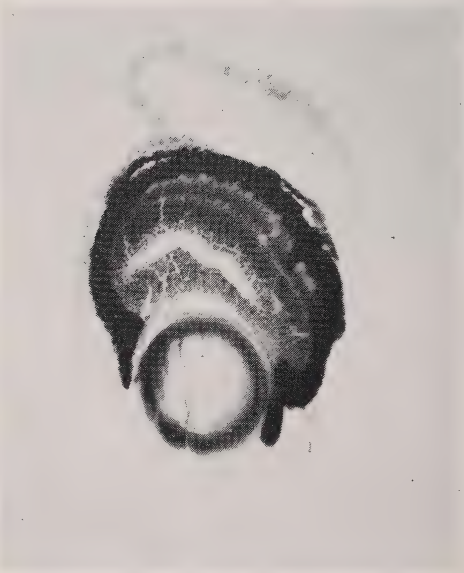

Figure 9.

number of eye defects. Of the total of 73 anomalous individuals produced by all the low temperature experiments, 46 showed some type of eye malformation of which monophthalmia occurred 15 times (Figs. 3 and 4), unilateral microphthalmia 14 times (Figs. 5, 6 and 7), anophthalmia 6 times, bilateral microphthalmia 5 times, various degrees of synophthalmia 5 times (Fig. 8) and cyclopia once (Fig. 9). The majority of these individuals also demonstrated some degree of general retardation and a few possessed other anomalies such as a short, deformed tail or a swollen pericardial region.

Thirteen animals showed general retardation of development with which was associated little visable blood, a small heart and a feeble pulse. Seven of these also had very short and tightly curled tails and the remaining six showed a large, swollen head and/or pericardial region.

Discussion

These results have demonstrated that the medaka fish reacts quite differently to two agents, one chemical and the other physical. Both have been shown to be effective in other species. On the one hand, trypan blue in suitable concentration caused a high mortality rate but a very low rate of malformation when applied to the early embryo for a 24-hour period. On the other hand, reduced temperature caused comparatively less mortality and considerably more malformation during the same period. The full meaning of these quantitative differences is not clear but at least they seem to indicate that in this species trypan blue tends to act upon the embryo in an "all or none" fashion, that is, either killing it or permitting normal development, while reduced temperature frequently does neither but produces what might be regarded as an intermediate result, that is, defective development.

In recent years considerable evidence has accumulated to suggest that different teratogenic agents act in characteristic ways on a given animal species (Wilson, 1955). This has been particularly well demonstrated in rodents and chicks where on several occasions more than one agent has been carefully studied in the same animal by one group of investigators. In most of these instances qualitative as well as quantitative differences in the types of malformations were clearly shown. This has been designated as "agent specificity," implying that each agent acts on the embryo in a specific way, for example, upsets a particular enzyme system, enters into competitive antagonism for a needed metabolite or in some other way interferes with growth or developmental processes. If two different agents happen to interfere with the same process at the same stage of development, the types of malformations produced should be identical. If they acted on different processes at the same stage or perhaps the same process at different stages, the malformations would not be alike and it should be possible to identify certain patterns as specific to the agent which produced them.

From his extensive experiments on *Fundulus,* Stockard (1921) concluded that all teratogenic agents act in a basically similar way by arresting development at some "critical moment." When development was later resumed the original delicately integrated schedule of organogenesis was never restored and the disproportionate growth that followed resulted in malformation. According to this hypothesis, interruption of growth becomes the only adequate stimulus for teratogenesis and the only other requirement is that growth be interrupted at a critical time in differentiation or organ formation. It would follow that all effective agents should act alike so long as they act during comparable periods in development. This was shown not to be the case in the present experiment. Trypan blue was effective to the extent that it caused a high rate of mortality but it caused only negligible numbers of malformations. Low temperature applied to the same animal at the same stages of development resulted in appreciably less mortality but somewhat more malformation. The specificity of the agent, therefore, seems to be operative in teratogenesis in this lower form as well as in the chick and rodents. It is worthy of incidental note that the medaka did not respond to either of these agents by forming double embryos, a defect which Stockard felt was directly related to treatment of the *Fundulus* embryo with low temperature or hypotonic solutions at a particular time in early development.

We have concluded that trypan blue cannot be considered an effective teratogenic agent upon the medaka embryo. If any such action exists at all, it is certainly to a minor degree and not comparable to the effects which have been demonstrated for several mammalian species and the chick. The findings of Waddington and Perry (1956) in regard to certain amphibian embryos and the conclusions of Ingalls (1957) concerning effects upon the zebra fish are, therefore, not substantiated by our work on the medaka. In fact, it must be said that a clear-cut teratogenic action by trypan blue upon any poikilothermic vertebrate has yet to be proved.

SUMMARY

Trypan blue in sufficient concentration causes a high rate of mortality among developing medaka embryos. This lethal effect is more pronounced in early than in later stages. At all stages of development and with all concentrations of dye used very few or no malformations were produced, and it is concluded that trypan blue is not an effective teratogenic agent in the medaka.

Exposure of medaka embryos at the 2-, 4- and 8-cell cleavage stages to temperatures of 6 to 7°C. for 24 hours resulted in maldevelopment in an appreciable percentage of the hatchling fish. Such treatment also raised mortality to 51.9% at the 2-cell stage and to more moderate levels at later stages. Doubling the time of exposure caused 100% mortality in all early cleavage stages but caused neither anomalies nor increased mortality at the 25-hour (neural keel) stage. Reducing the exposure to 12 hours resulted in no malformations and very little rise in mortality above control levels. When early cleavage stages were treated at 4°C. for 24 hours both malformation and mortality rose to levels comparable to those obtained with 6 to 7°C. Ocular defects were the predominant type of malformations, although short tail, curled body axis and generally retarded development were observed with some frequency.

ACKNOWLEDGMENTS

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LITERATURE CITED

BEAUDOIN, A. R., and J. G. WILSON
1958. Teratogenic effect of trypan blue on the developing chick. *Proc. Soc. Exp. Med. and Bio.*, 97:85-90, 8 figs.

FERM, V. H.
1956. Permeability of the rabbit blastocyst to trypan blue. *Anat. Rec.*, 125:745-759, 1 pl.

INGALLS, T. H.
1957. Congenital deformities. *Sci. American,* 197:109-116, 17 figs.

KELLICOTT, W. E.
1916. The effects of low temperature on the development of Fundulus. *Am. Journ. Anat.,* 20:449-482.

LEREBOULLET, A.
1864. Recherches sur les monstrousités du Brochet observées dans l'oeuf et sur leur mode de production. Resumé des expériences précédences. *Ann. Sci. Nat. (Zool. et Paleo),* Ser. 5, 1:257-320.

LOEB, J.
1915. The blindness of the cave fauna and the artificial production of blind fish embryos by heterogeneous hybridization and by low temperatures. *Biol. Bull. Wood's Hole,* 29:50-67, 13 figs.

STOCKARD, C. R.
1921. Developmental rate and structural expression, etc. *Am. Journ. Anat.,* 28:115-266, 32 figs., 6 pls.

WADDINGTON, C. H., and M. M. PERRY
1956. Teratogenic effects of trypan blue upon amphibian embryos. *Journ. Embry. and Exp. Morph.,* 4:110-119, 1 pl.

WILSON, J. G.
1957. Is there specificity of action in experimental teratogenesis. *Pediatrics,* 19:755-763.

OBSERVATIONS ON TROPICAL MARINE FISHES FROM THE NORTHEASTERN GULF OF MEXICO[1]

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Recent reports (Caldwell and Briggs, 1957; Briggs and Caldwell, 1957; Briggs, 1958) have revealed the presence of a Florida marine tropical shorefish fauna in the northeastern Gulf of Mexico extending for approximately 60 miles of shoreline from about Panama City to Destin, with the greater concentration of records at Panama City. The extent of this fauna inshore has not been clearly demonstrated—by species or geographical range. The tropical fishes might occur all along the western edge of peninsular Florida in deep water, but there are as yet no published records of occurrence inshore between Panama City and the Keys—despite extensive studies of inshore fishes at Alligator Harbor, some 120 shoreline miles east of Panama City (Joseph and Yerger, 1956); and at Cedar Keys, some 115 shoreline miles further east and south of Alligator Harbor (Reid, 1954; Kilby, 1955; Caldwell, 1954, 1955, 1957; Berry, 1958a, 1958b). Unpublished observations by other workers indicate that some species of tropical shorefish may occur, close inshore, further north along peninsula Florida than the Keys. West of Destin, the extent of the fauna is uncertain—there being unconfirmed and unpublished reports of tropical fishes (species unlisted) as far west as Pensacola, Florida (40 shoreline miles west of Destin), although my own limited collecting inshore there failed to produce any. Boschung, in his 1957 list of Alabama shore fishes (particularly Mobile Bay, 50 shoreline miles west of Pensacola), lists none of the typically tropical fishes recorded from Destin and Panama City.

The tropical fauna at Panama City and Destin is a summer one, and a possible explanation for its occurrence may lie in a combination of factors—pelagic larvae (or at least young that are known to drift in the shelter of floating seaweed) of the tropical species of fish there, and the recently discovered current patterns in the Gulf of Mexico. In this latter regard, Leipper (1954: 121) reports summer surface currents in the Gulf, and his illustration shows a sweep of a branch of the Gulf Stream flowing northward through the central Gulf from the Caribbean—where these fishes are always in evidence. This branch is shown as dividing off the Mississippi River Delta with the easterly section bending shoreward in the region including Panama City and Destin. Some young fishes, as inhabitants of floating weed or as pelagic larvae (hatched further south in late winter, spring, or early summer), could be easily swept inshore at this point, and there find suitable habitat until the cold of fall and winter drives them into deeper and warmer water or kills them. As corroborating evidence for such a recruitment of young, only a few adults are found. The great majority of the fauna consists of small individuals probably in their first year. The few adults may move to deep water in fall and winter and return inshore with the onset of warm weather, and while conditions may permit these few to spawn, it appears that the bulk of the summer tropical population may be maintained through annual recruitment from the Caribbean. Why *Acanthurus randalli* Briggs and Caldwell might have become established as a replacement in the northeastern Gulf for the more southern *A. bahianus* Castelnau is not understood. Perhaps future collections will show instead that it does not replace *A. bahianus,* but that both occur there. If the differences between *A. randalli* and *A. bahianus* are the result of ecological influence, it is surprising that the other tropical Western Atlantic species of the genus, *A. chirurgus* (Bloch) and *A. coeruleus* Bloch and Schneider, are not also influenced (Caldwell and Briggs, 1957: 4; Briggs and Caldwell, 1957: 43).

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[1] Contribution number 41 from the U. S. Fish and Wildlife Service Biological Laboratory, Brunswick, Georgia, and a contribution from the Florida State Museum.

The eastward section of the Gulf Stream branch noted above turns south after bathing the Panama City-Destin shore and flows offshore out of the Gulf through the Florida Straits. In its southward flow it causes some circulation of water back north inshore along the west coast of the Florida peninsula (Leipper, 1954: 121) which may deposit some of the tropical fishes, escaping from the main stream, along the southwestern shore of the Peninsula, and in addition may help populate the more offshore coral and sponge patches shown by Hedgpeth (1954: 206). The absence of tropical species inshore between Panama City and somewhere south of Cedar Key may be due in part to lack of suitable habitat and to too few recruits remaining in the current by the time it influences that part of the coast. Briggs (1958: 244) opined that the apparent differences between the shorefish faunas of the eastern and western Gulf are due to differences in bottom type. Therefore, the presence of many tropical elements in the eastern Gulf is probably influenced by the combined factors of suitable habitat and regular recruitment by currents from further south.

The occasional record of a tropical species from Texas (Baughman, 1950) may be the result of similar recruitment aided by the portion of the Gulf Stream branch that flows westward after it divides off Louisiana. Less frequent areas of suitable habitat (Briggs, 1958: 244) for the recruits would seem to account for the smaller number of records for tropical fishes in the northwestern Gulf—both as individuals and species.

The following notes on tropical species have been assembled to record one species each from Panama City and Destin for the first time, to indicate that specimens are now available of another species previously recorded only on sight records, to extend the range of a species known only from its type locality at Panama City, and to modify statements regarding three species recorded by Caldwell and Briggs (1957).

Lengths are standard length. UF refers to the University of Florida Collections at Gainesville. BLBG refers to the collections (no catalog numbers) of the United States Fish and Wildlife Service Biological Laboratory at Brunswick, Georgia.

I wish to thank William W. Anderson, Frederick H. Berry, and Jack W. Gehringer, all of the Brunswick Laboratory, for helpful criticisms of this manuscript.

ANNOTATED LIST

Abudefduf saxatilis (Linnaeus). In reporting this species from Panama City, Caldwell and Briggs (1957: 4) overlooked a paper by Baughman (1950: 252) which questionably included a supposed sight record of *A. saxatilis*, under the name of *A. marginatus* (Bloch), in a list of notes on Texas fishes. I wish to thank Victor G. Springer for bringing Baughman's paper to my attention. The Panama City record is thus the first from the *northeastern* Gulf of Mexico, an area often considered faunistically distinct from the northwestern Gulf west of the Mississippi Delta (see Briggs, 1958: 242).

Chaetodon ocellatus Bloch. This species previously was reported (Caldwell and Briggs, 1957: 3) from Destin, Florida. Specimens have now been taken at the jetties at Panama City by the staff of Florida's Gulfarium in June, 1958. These are: UF 7205, two, 18 and 39 mm.; and BLBG, two, 22 and 25 mm.

Baughman (1950: 252) listed this species from Blind Pass, St. Joseph's Island, Texas. Like the record of *Abudefduf* noted above, this Texas record was overlooked, and the specimens from Destin and Panama City are thus the first from the *northeastern* Gulf of Mexico and have the same zoogeographic significance as those of *Abudefduf*.

Chaetodon striatus Linnaeus. Although reported previously from Panama City (Caldwell and Briggs, 1957: 3), the record was based on sight observations only. Specimens collected by the staff of Florida's Gulfarium in June, 1958, from Destin, corroborate the earlier record of this species in the region. These specimens are: UF 7206, two, 35 and 39 mm.; and BLBG, one, 33 mm.

Eupomacentrus variabilis Castelnau. In an earlier paper listing tropical fishes from Panama City (Caldwell and Briggs, 1957: 4), the name *Pomacentrus xanthurus* Poey was tentatively applied to this damselfish. In a subsequent examination of the material, Loren P. Woods, of the Chicago Natural History Museum, applied the name *E. variabilis*.

Acanthurus randalli Briggs and Caldwell. In preparing the original description for this species (Briggs and Caldwell, 1957), specimens were available only from the type locality at Panama City. There is now an 88-mm. specimen (UF 5674), from off Destin, collected in the fall of 1956 by the staff of Florida's Gulfarium. While the distance involved is only some 60 shoreline miles, this specimen is of interest as it provides for the first time a "range" other than the type locality.

Dermatolepis inermis (Valenciennes). A single 365-mm. specimen, BLBG, was collected in the fall of 1957 off Destin by the staff of Florida's Gulfarium. Briggs (1958: 271) lists the range of this species as Bermuda and southern Florida to Fernando de Noronha, Brazil; and the Destin specimen is therefore apparently the first record from the northern Gulf of Mexico.

Thallasoma bifasciatum (Bloch). A 90-mm. specimen, BLBG, collected in the summer of 1958 by the staff of Florida's Gulfarium, apparently constitutes a range extension to the Panama City jetties from the Florida Keys. Briggs (1958: 284) listed this species as occurring from Bermuda and the Florida Keys to Colombia and the southwestern Gulf of Mexico.

Literature Cited

BAUGHMAN, J. L.

1950. Random notes on Texas fishes. Part II. *The Texas Jour. Sci.*, 2(2): 242-263.

BERRY, FREDERICK H.

1958a. Additions to the fishes known from the vicinity of Cedar Key, Florida. *Quart. Jour. Florida Acad. Sci.*, 20(4): 232.

1958b. Additions to the fishes of Cedar Key, Florida, and a list of Gulf of Mexico Carangidae. *Quart. Jour. Florida Acad. Sci.*, 21(2): 190.

BOSCHUNG, HERBERT T., JR.

1957. The fishes of Mobile Bay and the Gulf coast of Alabama. Doctoral thesis, University of Alabama, 1957. 626 pp.

BRIGGS, JOHN C.

1958. A list of Florida fishes and their distribution. *Bull. Florida St. Mus., Biol. Sci.*, 2(8): 223-318.

BRIGGS, JOHN C., and DAVID K. CALDWELL

1957. *Acanthurus randalli,* a new surgeon fish from the Gulf of Mexico. *Bull. Florida St. Mus., Biol. Sci.*, 2(4): 43-51.

CALDWELL, DAVID K.

1954. Additions to the known fish fauna in the vicinity of Cedar Key, Florida. *Quart. Jour. Florida Acad. Sci.*, 17(3): 182-184.

1955. Further additions to the known fish fauna in the vicinity of Cedar Key, Florida. *Quart. Jour. Florida Acad. Sci.*, 18(1): 48.

1957. Additional records of marine fishes from the vicinity of Cedar Key, Florida. *Quart. Jour. Florida Acad. Sci.*, 20(2): 126-128.

CALDWELL, DAVID K., and JOHN C. BRIGGS

1957. Range extensions of Western North Atlantic fishes with notes on some soles of the genus *Gymnachirus*. *Bull. Florida St. Mus., Biol. Sci.*, 2(1): 1-11.

HEDGPETH, JOEL W.

1954. Bottom communities of the Gulf of Mexico. *In* Galtsoff, Paul S., Gulf of Mexico. Its origin, waters, and marine life. *U. S. Fish and Wildlife Service, Fish. Bull.*, no. 89, 55: 203-214.

JOSEPH, EDWIN B., and RALPH W. YERGER

1956. The fishes of Alligator Harbor, Florida, with notes on their natural history. *Florida State Univ. Studies,* no. 22, *Papers from the Oceanogr. Inst.,* no. 2, pp. 111-156.

KILBY, JOHN D.
1955. The fishes of two Gulf coastal marsh areas of Florida. *Tulane Stud. Zool.,* 2(8): 175-247.

LEIPPER, DALE F.
1954. Physical oceanography of the Gulf of Mexico. *In* Galtsoff, Paul S., Gulf of Mexico. Its origin, waters, and marine life. *U. S. Fish and Wildlife Serv., Fish. Bull.,* no. 89, 55: 119-137.

REID, GEORGE K., JR.
1954. An ecological study of the Gulf of Mexico fishes, in the vicinity of Cedar Key, Florida. *Bull. Mar. Sci. of the Gulf and Carib.,* 4(1): 1-94.

Research Notes

NOTES ON *TRACHYPENEUS (TRACHYSALAMBRIA) SIMILIS* (SMITH), IN THE TORTUGAS SHRIMP FISHERY *

According to Idyll (1957, Fla. St. Bd. Conserv., Ed. Ser. No. 6:1-30), the entire Tortugas shrimp fishery is supported by one penaeid species, the pink shrimp, *Penaeus duorarum* Burkenroad. However, there are indications that other penaeid species may be of importance to the commercial catches in this area.

During January 1958, a two pound box of frozen headless "medium" shrimp, produced from Tortugas and packed by a Tampa shrimp firm, contained 52 "tails" of *Trachypeneus similis.* The balance of the box consisted of the pink shrimp, *P. duorarum.* The count of the small *Trachypeneus* "tails" was approximately 110 to the pound. The count of *P. duorarum* was about 74 to the pound. Therefore, nearly one-fourth of the "tails" were *T. similis.* In February, a similar box produced from the same area contained, along with small *P. duorarum,* 26 "tails" of the smaller *T. similis.* The specimens of *T. similis,* being "pink" in color, could easily be mistaken by the fishery as the young of the pink shrimp, *P. duorarum.*

"Tail" sections of headed shrimp show anatomical structures that are useful in identifying the various penaeids. In *T. similis* there are mobile spines on the lateral margins of the telson; in *P. duorarum* the telson is smooth and spineless. The sixth pleonic somite of *T. similis* is pubescent and no sutures appear along the dorsal carina; in *P. duorarum,* this somite is glossy, and two channel-like grooves occur dorsally along the carina. The petasmata of the males, located between the first pair of pleopods, are easily differentiated in these two species (Burkenroad, 1934, Bull. Amer. Mus. Nat. Hist., 68(2): 61-143, and 1939, Bull. Bingham Oceanog. Col., 6(6):1-62).

Other studies, by our laboratory, on the occurrence and monthly abundance of the penaeids present in the Tortugas shrimp area, have shown *T. similis* to be the most common shrimp next to *P. duorarum. T. constrictus,* a smaller species, is also present but in lesser numbers. The percentage of the combined *Trachypeneus* specimens, collected during January through March, 1959, was almost equal to the percentage of *P. duorarum* collected at the same time.

Hildebrand (1954, Publ. Inst. Mar. Sci., Univ. Texas, 3(2):230-366), found that *T. similis* followed *P. aztecus* in abundance on the Texas shrimp grounds. He reports that this species is thought to be the young of the larger shrimp by the fishermen of this area. He further states that *T. similis,* being a small shrimp, undoubtedly escapes through the meshes of the large shrimp trawls. Although a few specimens were found mixed with the canning shrimp, *P. aztecus* and *P. setiferus,* at Grand Isle, Louisiana, he concludes that this species has little commercial importance.

According to Guest (1956, Texas Game and Fish Comm., Mar. Lab. Bull. No. 36, Ser. 5:1-23), two species of *Trachypeneus* appear in the bays and in the Gulf along Texas. He reports that these shrimp are usually too small to be of commercial value but do enter the bait fishery. During our shrimp studies in the Tampa Bay area, specimens of *T. constrictus* have been found with *P. duorarum* specimens in the tanks of the local bait dealers.

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* Contribution No. 26, Fla. St. Bd. Conserv. Mar. Lab., St. Petersburg, Fla.

Various *Trachypeneus* species occurring in Indo-Pacific regions, Australia, Central and South American countries represent a large portion of the fisheries of these areas. Therefore, the value of this small shrimp from the Tortugas grounds should not be overlooked. Although the evidence presented here is based on a very small sample it suggests that *T. similis* is of more than minor importance. Accumulated data on the penaeids of Tortugas, being compiled for publication, should contribute a better knowledge of the shrimps from this area.—BONNIE ELDRED, Florida State Board of Conservation Marine Laboratory.

Quart. Journ. Fla. Acad. Sci., 22(1), 1959.

CANINE TEETH IN FLORIDA WHITE-TAILED DEER (*ODOCOILEUS VIRGINIANUS SEMINOLUS* GOLDMAN and KELLOGG)

Canine teeth in the upper jaw of North American deer are usually lacking although their occurrence has been reported by various authors. Nordquist (1941, Cal. Fish and Game, 27:39), observed canines in two male mule deer from California and Allen (1900, Amer. Mus. Nat. Hist., Bull. 12, pp. 191-262), in three white-tailed deer from Mexico. Van Gelder and Hoffmeister (1953, Journ. Wildl. Mgt., 17:100), report well developed upper canine teeth in a white-tailed deer specimen from Chiapas, Mexico. These latter authors examined 325 skulls in collections of the American Museum, Chicago Natural History Museum and the University of Illinois Museum of Natural History. Among these specimens the occurrence of upper canines was observed in 11 individuals, 3 of which were among those previously reported by Allen *(op. cit.)*. Van Gelder and Hoffmeister *(op. cit.)* conclude that canine teeth are apparently more common in Central American specimens because 6 of 8 in their sample from known localities were from south of the 24th parallel. Kellogg (*in* Van Gelder and Hoffmeister, 1953) reports one or two instances of canines in 900 skulls of white-tailed deer he examined and additional observations of canines have been reported by Severinghaus (Editor's note in Van Gelder and Hoffmeister, 1953) for deer in New York. A cursory examination of 18,000 specimens in New York revealed the presence of canines in 23 individuals. Severinghaus indicates, however, that two-thirds of these deer were seen only in fresh condition at checking stations and suggests that some very small canines were probably overlooked.

In connection with recent studies of Florida white-tailed deer skulls from various localities definite examples of upper canine tooth development have been observed. A total of 95 skulls was examined and the presence of upper canine teeth was evident in 3 males, 2 adults and a yearling, from Volusia County in east central Florida, and a yearling female from Collier County in the extreme southwest part of the state. In the 2 adults the canines were well developed and the diastema from the anteriormost margin of the alveolus of the canines to the posteriormost margin of the alveolus of the second premolars (following the formula $P\frac{0\ 2\ 3\ 4}{0\ 2\ 3\ 4}$ suggested by Riney, 1951, Journ. Wildl. Mgt., 15:1, pp. 99-100), was 4.4 cm and 5.0 cm respectively. In the case of the yearlings only rudimentary canines were evident and it is probable that the presence of these teeth would have been overlooked had the animals been examined in a fresh condition.

The relatively high frequency of canine teeth occurrence in Florida deer (4 of 95 or about 1:28) compares with a ratio of 1:30 (11 of 325) reported by Van Gelder and Hoffmeister (*op. cit.*). An interesting aspect of the Florida study is that 3 of the 4 specimens possessing canine teeth were observed in a series of 13 skulls collected from the Tomoka Wildlife Management Area in Volusia County during the 1957-58 hunting season. Whether the high incidence of occurrence in this population is due to chance alone or is genetically linked remains to be determined, but nevertheless is an unusual situation and merits further investigation.

Access to deer skull collections of Robert Garrison, Stephen Fickett and Donald D. Strode of the Florida Game and Fresh Water Fish Commission is acknowledged. Assistance given by various Commission Wildlife Officers is also appreciated.—CHARLES M. LOVELESS and RICHARD F. HARLOW, Florida Game and Fresh Water Fish Commission.

Quart. Journ. Fla. Acad. Sci., 22(1), 1959.

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Vol. 22 **June, 1959** **No. 2**

Contents

Morton—The Dynamics of City Development 81

Arata—Effects of Burning on Vegetation and Rodent Populations in a Longleaf Pine Turkey Oak Association in North Central Florida 94

Laessle and Wharton—Northern Extensions in the Recorded Ranges of Plants on Seahorse and Associated Keys, Levy County, Florida 105

Walton and Hobbs—Two New Eyeless Ostracods of the Genus Entocythere from Florida 114

Rossman—Protozoan Fauna of a Limestone Sinkhole in North-Central Florida 121

Sogandares-Bernal—Four Trematodes from the Black Skimmer, *Rynchops nigra* Linn., (Aves: Rynchopidae), in Gasparilla Sound, Florida, Including the Description of a New Genus and Two New Species 125

RESEARCH NOTE

Arata—Revaluation of the Pleistocene *Urocyon seminolensis* from Florida 133

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THE DYNAMICS OF CITY DEVELOPMENT

RICHARD K. MORTON
Jacksonville University

Cities are ancient sociological and economic concentrations of human beings. While developing within various civilizations at different times and for different reasons, they all had some protective, economic, or sociological function. They were feasible wherever and whenever man's life progressed beyond the nomadic and agricultural stages.

It is largely the urban areas that provide the power and creativeness that give shape and meaning to our modern industrial civilization. Whatever influences their growth is of increasing importance to all who are concerned about the problems of today's world. It is of great significance today to identify and to analyze some of the factors that produce or inhibit the dynamic forces of urban life.

A city is a center of work, and a concentration of workers. It has economic, social, and ethnic foci around which its life cells develop. As Quinn (1955: 23-24) and others have pointed out, it is large enough to be self-perpetuating and can resist relatively severe shocks. It is capable of absorbing many elements from its environment while maintaining its original identity and purpose. It is a community large enough to have developed measurable weight of public opinion and gravitational power, and one in which many expressions of its nature and will are administered indirectly and impersonally. It is also composed of complicated interrelations of values and resources—many of which aid the efficiency of its culture and productivity. Some of its network of forces and activities are contradictory to one another, and some are virtually unrelated to one another. People of many types urbanize

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for the most part because life to them is more pleasurable and profitable that way. There is a current belief that if you wish to amount to anything or show that you are sophisticated about modern life, you should live in a city.

It has been shown that variables in modern growth occur for many reasons, one of them being the degree to which the city draws resources from the rural areas. Rural values and man power often come to their greatest fruition when transplanted into the cities. The city provides the stage, the market, the forum, the professional and economic base upon which achievement can be built and recognized. This is in spite of the fact that—believe it or not—the real provincials live in the cities. These are the often caricatured individuals who know virtually nothing outside the limited skill by means of which they earn their living. City life is often segmented and fragmentary, with some values and drives being stunted by preoccupation with purely intraurban and artificial concerns. Inert and fixed elements are there as well as the kinetic and highly mobile.

Students of government and sociology find that in some instances there is evidence of a *micropolis* psychology—i.e., a small community has accepted the belief that it is and will remain a minor city, and can never acquire the reputation or resources of its larger neighbors. This often inhibits officials' or citizens' drives to make necessary improvements. The reverse is true in some cases: a community acquires a *megalopolitan* complex—to use Prof. Max Lerner's colorful expression (in his volume, "America as a Civilization," 1957, Simon and Schuster, p. 155). Such a city usually has pretensions if not delusions of grandeur. It develops to an advanced degree its gravitational pull exerted on the region as a whole, and is usually classified also as *cosmopolitan.*

As Davis (1949: 336-341) has noted in "Human Society" and other volumes, a city exerts influences far beyond the area of its own territorial sovereignty. The variety of the activities of its citizens provides adequate implementation for this. Its influences include a kind of provincial control over its satellite suburbs. It develops its own totemism, its sets of mores, customs, and attitudes. It is a center of confluence as well as influence. It is also a place of both infusion and diffusion of many agencies and interests.

Cities stand out prominently even in ancient history. (Biesanz and Biesanz: 1953: 99-100). Arnold J. Toynbee's famous "Study of History," published over about a twenty-year period beginning in 1934, traces the particulars of why communities enlarge and settle as they do. One of the more recent volumes, dealing with a sadly neglected although still strategic section of the Middle East, is Nelson Glueck's "Rivers in the Desert". This is a fascinating account of the backgrounds and anthropological and ecological developments in the Negev. Out of these ancient movements seem to emerge the causes of many modern evolutionary circumstances bearing upon the inevitable rise of larger communities or cities. Impetus for all this undoubtedly came in areas which were strategic in world history and in the flow of the tides of politics, warfare, trade, and human migration. Many cities arose at the crossroads of conflicting cultures and commercial empires and political powers. A cursory examination of the story of Africa, South America, China and other Asiatic countries will show this. The Aztecs, Mayans, Egyptians, Hittites, Phrygians, Phoenicians, and many others add to the story.

The Greek city-state and its concept of the polis, brought civilization to a higher point. Among the peoples of ancient Mexico and South America, as among the Greeks, the city became the powerful unit. An inclusive state or regional sovereignty was not wanted and would have been difficult to create. This absence of centralization continues, of course, through the heyday of such cities as Venice, Genoa, Constantinople, and the history of many Western German cities in the days that followed Charlemagne. In Roman times power became centralized in Rome, although provincial centers continued to exert considerable force.

During the early Middle Ages, and in periods of weak kings, cities began to flourish, politically, socially, economically. They filled a need just as did those of earlier times. The lords of the manor and their estates became virtually independent political entities. They had their own armies, laws, parish churches and priests, taxes, courts, economic and social structure. Thus many cities grew and prospered because there was little or no higher power to dominate or control them.

The sea trade and vigorous political activities of this period of the Middle Ages also guaranteed increased importance of cities, as did the perennial wars, and military activity. Centers of power for either Church or State necessarily meant dependence upon cities. We are to a great degree heirs of urban patterns and impetus established long ago and simply given new motivation and implementation by the industrial era which began with the technological developments of the nineteenth century.

The city takes on a different set of relationships when it is a subordinate part of a regional or national government, especially a strong and aggressive one. This is true today in States where enterprises sought by the large cities are often prevented by the votes of the rural districts. In some areas, too, lagging county government impedes the progress of included or adjacent cities. Aggressive national or state controls often severely restrict cities. A city population usually contains people who prefer some unity of action with converged business enterprises governed by many regulations. They also prefer a greater division of labor to secure greater efficiency than that produced with unrestricted individual freedom. These people approve of what can be done by pooled interests and man power, by cooperative action, by specialization with all its attendant advantages. They value crowds and what can be derived from or produced by crowds. A psychology and philosophy of distinctive characteristics develop within such an area.

As Johns and DeMarche indicate (1951: 9-24) cities contain many artificial elements. Many of these elements are remote from the soil and the basic needs of human life. As urbanites follow their businesses and professions, they create other values. Indeed city life seems to mean more than the sum of its parts, and as a city puts into operation what it has to offer, this very process produces other capacities. Professional life may be on a higher level than elsewhere, and competition is usually keener.

Cities may be classified as industrial, primary service, distributing, or special type areas, according to the particular reasons behind their origin and development. In some instances, expansion has been by a number of "swarmings" of business or residential interests, or as clusters of the same have settled down in a favorable location. Some of these active centers are highly unified, having one clearly defined focal point. Others are much more decentralized, multifocal, or of federated elements. We have many examples, throughout the country of what I call the *binary* or two-center form (e.g., Minneapolis-St. Paul, Tampa-St.Petersburg, Central Falls-Pawtucket, R. I.). The dynamics and potentialities of their development may vary greatly.

The Biesanz study (*op. cit.*, 116-129) shows how cities are needed to provide facilities to meet advanced human needs and to supply suitable areas for highly skilled activities. Such analysis also indicates that man's fullest development finds expression and its best implementation in cities. The authors consider the mosaic of subcultures, the dichotomy of compulsions and freedoms, and the constant flux and often oscillating thrusts of a city's life. They also show the role that stratification by social class and economic resources plays.

Bierstedt (1957: 370-386) adds that in a city there is the phenomenon of people engaged in repeated regathering according to a diversity of roles. The city is the result of inevitable group objectives and methodology. The culture of a city is often strengthened by the fact that, in its environment, individuals may balance an inferior role in one field with a superior role in another. Again, many are in a position not to care very much what their role is. As laborers or workers in middle-class pursuits, little is denied to them that they really want. They may receive wages, for instance, far higher than the salaries of those in a social or intellectual or professional class above them. Status can be concealed in a city, too, as well as one's moral or religious principles. Social unrest is definitely held down, because the technical possibility of vertical mobility is still real for most of them. Integrating forces are active in economic, governmental, and business activities, and these tend to spread their influence into other fields. Ecological studies show, that people of similar interests and vocation tend to live near one another. In studies of city neighborhoods I have found confirmation of the fact that apartment dwellers have much less orientation, local pride, and "rootedness" than do occupants of their own residences. This is especially true in suburbs.

Cole (1958: 41-56) contributes many analyses of specific problems which demonstrate how and why cities progress or lag as they do. He shows particularly the influence of age and internal organization and of the ecological elements involved through many human relationships, especially through the suburbs and fringe outgrowths.

Various types of segregation, decentralizing tendencies, invasions, and pollutions exert great power over cities. Some sections of them become exhausted economically and socially through abnormal circumstances. Others are severely affected by some political or commercial development. In some cases there are too many depleted and low-grade districts for the others to counterbalance.

Cole (*op. cit.*) also has helpful data which remind us that some cities, largely because of defects in the original planning and because of unfortunate policies in later development, show what I call a form of "arteriosclerosis." Their lines of transportation have become clogged, too many people and materials flood along their rights of way, and they become unable to handle the work for which they were designed. Photographs of many city blocks will show clearly that so many businesses and enterprises pour out people and materials at critical points along thoroughfares, that they make bad situations worse. We need even more block-by-block studies of total activity in relation to public facilities to handle it. What do these roads carry? What are the data: e.g., number of people seeking parking there; approximate number who do business there; times of peak loads for the streets; direction and schedule heavy traffic; or in other words careful outlining of the hour-by-hour pulsations of the city's activity in that area.

Streets that were designed for residential service now carry downtown traffic in some cities. Others built to serve relatively little activity now struggle with the loads put upon them by newly erected hotels, apartment houses, skyscrapers and factories. Narrowness, poor surfacing, dangerous curves or intersections, obstructions that jut out too near the flow of traffic, unwise laning and parking—these are familiar collateral handicaps.

Obesity may also develop when a city becomes bloated or over-loaded with heavy concentrations of trucks, buses, frequent assemblies of the public, or something of the sort. There are unfortunately parallel activities of community and commercial groups that can rapidly fatten an area's traffic.

Senility is an urban phenomenon which arises frequently in connection with failure to repair, renew, or enlarge facilities which once were adequate. In connection with this, there may have been a shift in or influx of population, rezoning, the installation of some large activity, or the general inability to meet the costs of maintaining what may have been an overly ambitious enterprise. Just one bad move permitting the operation of a noisy substation, transfer zone, sports arena, or unpopular club, may be enough to make any section grow old before its time.

As Cole (*op. cit.*, 239-255) states, a city's life or development is much conditioned by how it derives its water supply and power. Sometimes these must come from a distance or require expensive tunnels or construction work. If such utilities and services are never fully satisfactory, or if they are too expensive, the city can suffer much. What must be done to secure radio and television communications, newspaper service, its sanitation system, and provisions for health will be tremendously important. Failure to have adequate physical equipment, well-manned and maintained, may be serious. Some cities must go to great trouble and expense to provide their sanitation and incineration systems, their regulation of river or lake pollution, their supervision of near-by manufacturing plants which produce offensive odors, and the like.

So far as basic planning and morphology are concerned, most authors recognize the concentric zone or circle, multiple nuclei, and sector methods. Some cities, it is evident, seem to produce growing edges or "mantles". Others seem to favor sectors of advance, while other areas remain relatively stable. Still others display more than one center of basic life and development (e.g., the binary type which may straddle a river or ridge).

I prefer to recognize some other types as equally characteristic of urban development. There is, for example, the *linear* form which follows some artificial contour such as a highway, or railroad line. The *topographical* form follows a natural contour such as a valley, ridge, river or swamp.

Other types are these: the *tangential,* sending out some line of commercial and/or residential development in an oblique direction, possibly because some interest decides to locate a facility such as a large ranch, hospital, resort, popular restaurant or dance hall or sports center, in that direction; the *star-shaped,* so called because it operates with several *suburban* points, as distinct from the multiple nuclei, these points often spreading out into what are really arcs of a circle the center of which is at the heart of the downtown area; the *mutational* which results when a section originally of one kind is adapted to other purposes due to population shifts or new installations; the *conglomerate* which represents a mixture of elements, with minimum planning, becoming bunched together; and the *operational* which usually comes into being to serve some specific enterprise such as Oak Ridge, Tenn., Zion, Ill., Cape Canaveral, Fla.

Hunt (1955: 211-218) presents material indicating the influence of neighborhoods which can differ radically. In these may be settled some ethnic group, some business or residential interests associated with military establishments, race tracks, public institutions or the headquarters of a large corporation, such as an insurance company. "Cell" growth can proceed at irregular paces and intervals. The virility and expansive power of some urban settlements will also be superior to those of other groups.

Mercer (1958: 179-191) properly identifies a biotic community—that is, a community of living organisms, the life elements in an urban situation. In many cases an economic or material situation may be linked with a progressive or a stagnant biotic community. Such groups vary enormously in what is called "local pride" or "spirit." Where there is a rich development of community spirit, there will very likely be agencies making for expansion and community improvement. Many of these will operate through volunteer workers. No urban community to my knowledge could do without its voluntary man-hours of labor and privately supported agencies. Without them basic revamping of municipal budgets and social welfare procedures would be required. These community-minded enterprises are found in the religious, social welfare, youth, educational, vocational, political, and health fields.

It is a combination of public and privately supported activities that carries on the work of a modern city. In many instances, however, thousands of skilled workers are lost within the city and do little in any organized way for its advancement. A survey of Jacksonville, Fla., a few years ago, showed that out of over 165,000 wage earners there were only about 1,200 actively engaged in major community enterprises.

Johns and DeMarche (*op. cit.:* 1-9) list among the factors that may militate against the dynamic of city development too rapid growth, the pull of vested interests, the influence of needs long unmet, duplication of activity, and competitiveness of organizations. Much in the Barnes and Ruedi analysis (1942: 623-639) shows how problems can pyramid until a city is unable to use its basic plan to meet the modern situation. It has problems of mounting unemployment possibilities and fears (to say nothing of realities), transients, immigrants, maladjusted additives to its population. It has urgings for more recreational and parking facilities, more housing accommodations, more provision for health and safety. As

Quinn (*op. cit.,* pp. 176-187) points out, urbanized environment is distinguished by extreme individualization, calculatingness, putting on a front, and problems in personality adjustment. He shows also that farm children are on the whole better adjusted in school. Greater demands for mental health ministrations, handling personal problems, regulating minorities, and orienting new groups are often made.

Within the urban community the individual finds greater restrictions (e.g., ordinances, customs, codes in businesses and professions), greater expenses and higher taxes, more competition, and more need for keeping up with the techniques of the world at large. As Wicks stresses (1958: 205-249), there is more pressure to attain and retain stature (so long as the individual considers himself in the running on that level at all), and more contending for placement in all possible vocations. It is a land of middlemen and those who hand on or process what others have produced. Labor, intergroup, and business-relationship problems color the rest of life. A factor not listed by analysts is that there may be business or other cycles in a limited area poorly equipped to handle them. Also there may be seasonal pulsations which bring distress because of certain basic inadequacies in the city. Within that area, too, may be found subterranean Communist and other subversive or antisocial activities.

Warren (1955: 57-77; 292-306), presents data on the distribution and functions of individuals and organizations needed in community development. His work is a manual for city planners and developers as well as for citizens who wish to identify themselves with some specific project. It is generally established that good political conditions and relationships with higher governments will aid a city. Every group needs some instrumentation in the form of youth-adult council, intergroup council, business men's association, a really competent chamber of commerce, an inclusive educational council, neighborhood recreational societies, health and physical education centers. Others are rapidly including educational television committees, adult education associations, psychiatric clinics, clinics and homes for the elderly, handicapped, and crippled, as well as contact points with transients and visitors who may be in financial or some other kind of need.

Young and Mack (1959: 213-229), indicate how all a city's life centers around the drive for economic and social status on the part of certain classes and on its constructive contacts with the outside world. They say this: "American culture makes upward mobility an ethic, and offers both symbolic and material rewards to those who succeed." This drive is built by resources from immigration, technological advance, education, differential fertility, the familiar cultural, intellectual, and economic inequalities of men.

As Quinn (*op. cit.*: 117-125) demonstrates, changes of population levels or concentrations effect certain measurable results, as would deterioration of transportation systems. Addressing another problem, this author (237-257) shows the primary relevance of housing accommodations. Redistribution of incomes, increasing the "real" income, and regulation of housing costs (of construction, mortgaging, and rental) are important methods of dealing with this basic city need. Government and industry alike have erected many facilities, and some private agencies have offered some developments aided by a subsidy.

Cities in several sections of the United States have benefited from places aided by some exceptional investment of capital in favored projects. Where a small city has acquired a large hospital, college, corporation, or government installation its economy and social life will be nearly revolutionized.

The availability of adequate capital locally invested must not be minimized. Qualified leadership can not be omitted from the story. The proper exchange of money and movement of goods, the credit situation, the stability of basic payrolls and resources, the proper diversity of enterprise—all these enter into the situation. If capital is too much concentrated, if consumers suffer abnormal losses, if there is a too rapid rise in land values or rents, or if there is an unfortunate hierarchy of class control or of municipal powers that may too long neglect municipal improvements, troubles will come rapidly.

There may also be mediocre schools and city clubs or societies, as well as little willingness to pay the costs, publicly or privately, for necessary modernization of the city. There may be unfortunate and hampering ordinances or lax law enforcement, clogged courts, improper valuation of property. The desire of some individuals to participate in a movement of advancement and expansion may be largely nullified by the inertia or dimness of vision of others.

I take the position, however, that we cannot assume that present conditions now operative in cities will necessarily continue. There is less need, for example, for immense concentrations of residences within the inner core of the city. Suburbs and fringe areas—more and more distant—will relieve pressure in this respect. Activities and locations can easily be more dispersed. New and more rapid methods of handling many matters will rival the wonders of missiles and interplanetary travel. The power of the city will not reside in density, congestion, proximity. In the early days, of course, problems of defense, sanitation, lighting, communication, and so on made this spatial localization vital. But now the inner core can be given over largely to planned and specialized storage and other industrial purposes. The suburbs and fringes will have the residences and subsidiary shopping and supply centers. New rapid transit means will whisk people to and from parking centers.

We are about to see, I think, a definite change in the basic philosophy of city life and planning. City people can have city benefits without living within cities. Davis (*op. cit.:* 341-342) and other sociologists apparently believe that our city problems will alarmingly increase until crises arrive. I think, however, that we are already seeing the dispersal and deployment of many agencies and population groups out into the suburbs and beyond. What we are seeing is the progressive urbanization of the rural and the gradual reduction of differences between the two areas. The dynamic will lie in the suburbs so far as the biotic community and domestic interests are concerned. The pulsations of the business and professional spheres will continue to center near the downtown areas. We can now have a city which is not centrifugally revolving around or dependent upon a core, but which contributes its own daily, indigenous elements to the life of the entire region. Just how this will be worked out and implemented, who will do the work, at what cost, what the cultural and social ramifications will be, and what difficulties will be met—these are problems for the future to experience and resolve.

LITERATURE CITED

BARNES, HARRY ELMER, and OREEN M. RUEDI

1942. Part VII, Chapter 24, on American society moving into an urban pattern, and Chapter 26, on community organization, in second edition of The American Way of Life. Prentice-Hall, Inc., Englewood Cliffs, N. J.

BIERSTEDT, ROBERT

1957. Part V, Chapter 12, on city and country, in The Social Order, an introduction to sociology. McGraw-Hill Book Co., Inc., New York.

BIESANZ, JOHN, and MAVIS BIESANZ

1953. Chapter 8, from rural to urban living: our shifting population, and Chapter 9, from rural to urban living: our changing society, in An Introduction to Social Science. Prentice-Hall, Inc., Englewood Cliffs, N. J.

COLE, WILLIAM E.

1958. Parts 2 and 4, on urban structure and function and urban planning and development, in Urban Society, a college textbook in urban sociology. Houghton Mifflin Company, Boston, Mass.

DAVIS, KINGSLEY

1948. Part III, Chapter 12, on rural and urban communities, in Human Society. The Macmillan Company, New York.

HUNT, ELGIN F.

1955. Part 2, Chapter 8, on rural and urban communities, in Social Science, an introduction to the study of society. The Macmillan Company, New York.

JOHNS, RAY, and DAVID F. DeMARCHE

1951. Community Organization and Agency Responsibility. A study of the process of community organization for social welfare. Association Press, New York.

MERCER, BLAINE E.

1958. Chapter 7, on the community and its organization, and Chapter 15, on control and change in society and culture, in An Introduction to the Study of Society. Harcourt, Brace and Company, New York.

QUINN, JAMES A.

1955. Chapter 1, on preliminary characterization of the city, Chapter 2, on location and size, Chapter 7, on smaller worlds within the city, Chapter 8, on housing the people, and Chapter 15, on urban planning, in Urban Sociology. The American Book Company, New York.

TOYNBEE, ARNOLD J.

1951. Volume 2, the range of challenge and response, the stimulus of adverse conditions and of new ground, in A Study of History. Oxford University Press, New York.

WARREN, ROLAND L.

1955. Chapters 5 and 17, on community planning and community organization, in Studying Your Community. The Russell Sage Foundation, New York.

WICKS, ROLLO E.

1958. Part 3, Chapter 10, on achieving a stable economy, and Chapter 11, on adjusting conflicting economic interests, and Chapter 12, on consumption in a technological society, in Man and Modern Society. McGraw-Hill Book Company, New York.

YOUNG, KIMBALL, and RAYMOND W. MACK

1959. Part 2, on social organization, including Chapter 13, on social mobility and chapter 16, on folk and urban communities; Part 3, chapter 19, on the structure and functions of social institutions, in Sociology and Social Life. The American Book Company, New York.

EFFECTS OF BURNING ON VEGETATION AND RODENT POPULATIONS IN A LONGLEAF PINE TURKEY OAK ASSOCIATION IN NORTH CENTRAL FLORIDA

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This study considers some of the effects of a mid-winter burn on the vegetation and rodent populations in a longleaf pine-turkey oak association.

The importance of fire in the establishment and maintenance of longleaf pine-turkey oak (*Pinus australis-Quercus laevis*) associations in southeastern United States has been considered by Laessle (1942) and Garren (1943). In addition to fire, which has probably occurred since prehistoric times, logging activity in the southeast has removed much of the longleaf pine in such areas, allowing dominance by turkey oak (Laessle, *op. cit.*). This fire-climax association, more xeric than would probably be the case were fire not of such long standing importance, has been the subject of various studies by foresters primarily concerned with the effects of fire on forest species of economic importance (Heyward, 1939; Wahlenberg, et. al., 1939; Shepherd, 1953; Lay, 1955). Little attention appears to have been given to the influence of burning on the fauna of this community.

Description of the Study Area

The area is located 5 miles west of Gainesville, Alachua Co., Florida, and comprises several hundred acres of typical pine-oak land. The ratio of pine to oak varied from approximately 1 to 20 near the site of the burn in an area that had been recently logged, to approximately 1 to 2 in an area that had not been logged for nearly 25 years. The major ground plants consisted of perennial grasses (*Sporobolus, Aristida,* and *Andropogon*), chinquapin (*Castanea alnifolia*), dog fennel (*Eupatorium* spp.), and partridge pea (*Chamaecrista* sp.). The grasses formed a dense "mat" giving in some areas up to 100% cover at 1 ft. above the surface (Fig. 1). The area of the burn was dominated by turkey oak, with few mature solitary pines about which reproduction of the past 6 to 8 years was evident.

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[1] Contribution from the Department of Biology, University of Florida.

According to local residents, the area had never been cultivated or grazed, but burning had occurred every 8 to 10 years for the past 30 years. The most recent burn was reported to have occurred in 1950, although growth rings on turkey oak sprouts and burn scars and growth of sapling pines indicated that the field was burned as recently as 3 or 4 years ago. The abundance of partridge pea and dog fennel provided further evidence of a more recent burn.

Local inhabitants reported that the area was most recently logged during 1952-53. Numerous unrotted pine stumps, 1½ to 2½ ft. in diameter, gave evidence of this cutting.

The area was burned by hunters during the first week of January, 1958. The extent of the burn was approximately 150 acres, and was limited by a sand road on the west and a semicircular narrow fire-break.

METHODS

Vegetational studies consisted of a general survey of the area to determine the major herbaceous and shrubby plants. No attempt was made to make this survey inclusive. The more common plants were determined in order of abundance, along with a few other conspicuous forms. Relative abundance and ground cover were determined by the use of three 3 ft. x 50 ft. belt transects. Plant names follow Small (1933).

Small mammal populations were sampled at approximately 6 months, then at 6 and 4 weeks, prior to the burn, with trap lines consisting of 2 Sherman live traps per station, these latter spaced at intervals of 20 yds. Populations after the burning were estimated by three trap lines: one in the burned area, another along the fire break in unburned habitat, and another 100 yds. within the unburned area. Each line was composed of 10 stations with 2 traps per station. Trapping was conducted for 5 successive nights, twice in February, once each in March, April, May-June, and September.

Prior to the burning 150 trap-nights were recorded. Following the burning, 1800 trap-nights were recorded on the three established lines. All mammals taken alive were marked and released. An attempt to estimate mammal populations by the dropping board technique (Emlen, 1957) proved unsuccessful, since the animals were apparently not attracted to the boards to defecate. A

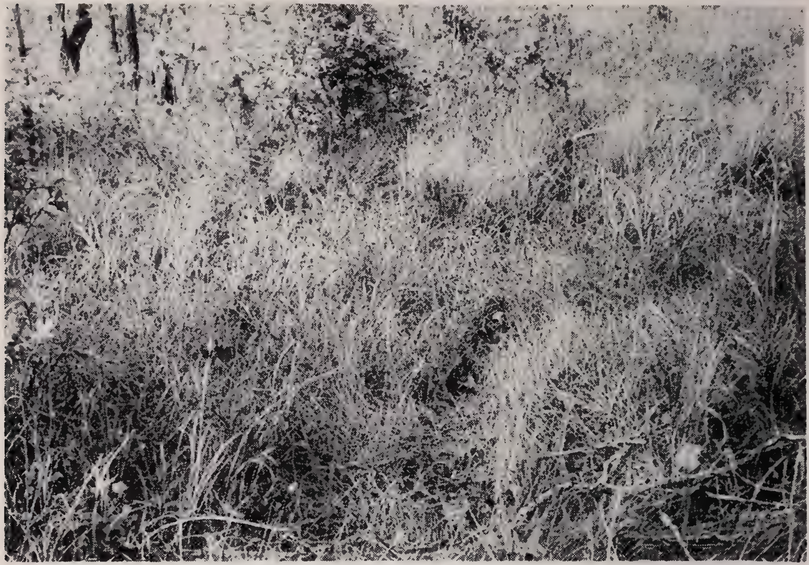

Figure 1. Unburned area in February, 1958; burned area similar prior to burning.

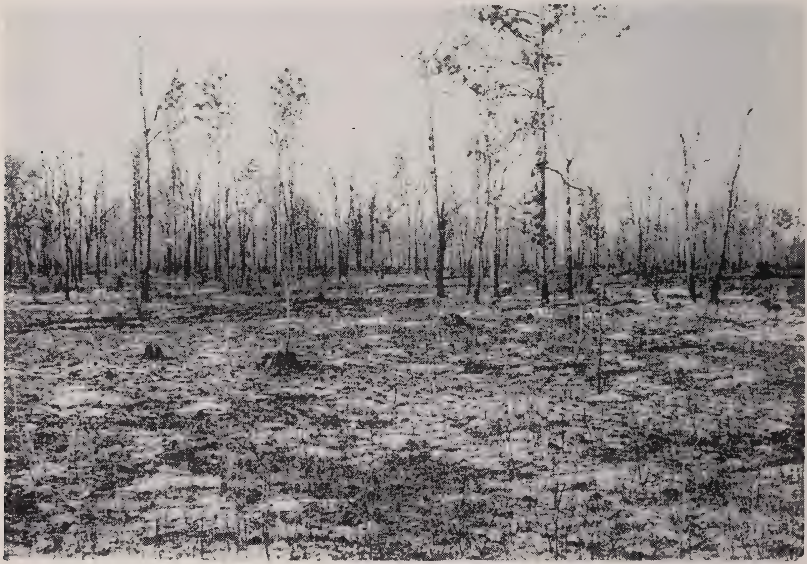

Figure 2. Burned area in February, 1958, one month after burning.

factor in this lack of response to the boards may have been the abundance of open sandy patches in the area.

Results

Vegetation: The heavy cover of the area prior to burning (Fig. 1) was composed primarily of clumps of perennial grasses and patches of dog fennels, partridge pea, chinquapin, and turkey oak saplings. The burn, coming after a hot and dry summer and fall destroyed virtually all ground cover (Fig. 2). Temperatures severely cold for this region occurred during January and February following the burn, so that cover was scanty for some time. The appearance of a number of species of plants was delayed by as much as a month past the normal.

Disregarding the usual seasonal variation, the first appreciable change in the aspect of the area occurred in March, with growth at the bases of burnt clumps of wire-grasses, and the emergence of chinquapin and turkey oak sprouts from underground stems. The few plants present did not alter the gross aspect of the area, however. Ground cover was no higher than 5% in the densest regions, and still completely lacking over most of the area.

In April, the aspect of the burned field had changed. From a distance of several hundred yards, the field appeared green and totally covered (Fig. 3). In reality, however, though ground cover was up to 10-15 per cent, it was not dense, but restricted to leaf cover one-two ft. above the ground. Vegetative reproduction by wire-grasses, turkey oak, chinquapin, bracken fern (*Pteridium aquilinum*), poison ivy (*Toxicodendron radicans*), and seedlings of partridge pea, made up the majority of the plants of the area. Also present were *Andropogon* sp., *Hymenopappus scabiosaeus, Berlandiera subacaulis, Lespedeza* spp., *Penstemon australis, Rhus copallinum,* and an unidentified panic grass. The large number of perennials present is a further indication of the frequency of the burnings in the area. Had the burnings been less frequent, a higher proportion of annuals would have been expected to have invaded the burned area soon after the fire.

The composites, poison ivy, partridge pea, and bracken fern were in far greater abundance in the burned area than in the unburned, where they occurred primarily along paths, and in areas of disturbance caused by pocket gophers (*Geomys pinetis*) and gopher turtles (*Gopherus polyphemus*). Seedlings of partridge

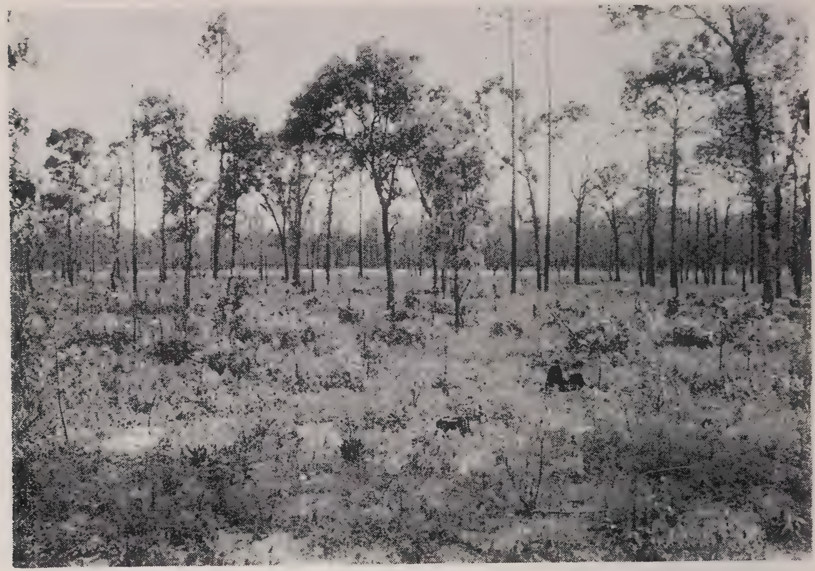

Figure 3. Burned area in April, 1958, three months after burning.

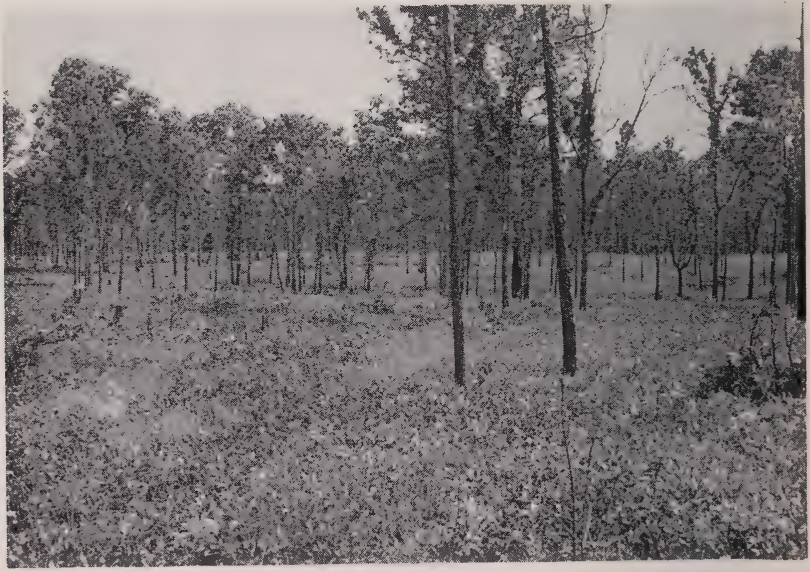

Figure 4. Burned area in June, 1958, five months after burning.

pea were estimated to be 10 to 20 times more abundant in the burned area.

By the end of May and early June, considerable growth of the established plants and an increase in ground cover were apparent (Fig. 4). Ground cover varied from 10-50 per cent over much of the area and averaged about 35 per cent. Poison ivy and bracken were less evident, whereas dog fennel, partridge pea, and *Andropogon* were more conspicuous. Other conspicuous plants making an appearance about this time were *Asclepias tuberosa, Rudbeckia* sp., *Bivonea* sp., *Ipomoea pandurata, Bradburya* sp., *Tetragonotheca helianthoides, Cuthbertia* sp., *Piriqueta caroliniana, Croton* sp., *Baccharis* sp., and *Vitis* sp.

No observations were made in July and August. In September ground cover was estimated at 50 per cent, though occasional bare patches of sand would reduce this considerably in some areas. The wire-grasses composed the majority of herbaceous vegetation, with considerable amounts of dog fennel, partridge pea (now dried and seeds discarded), chinquapin, and small turkey oaks. The major difference between the burned and unburned areas was the greater amount of dog fennel in the burned area, as opposed to a dense "mat" of wire-grass of the recent and preceeding seasons in the unburned area.

Mammal Populations: Some information on the small mammal population of the area prior to the burn was available. In June, 1957, 17 oldfield mice (*Peromyscus polionotus*), 1 Florida deer mouse (*Peromyscus floridanus*), and 6 cotton rats (*Sigmodon hispidus*) were taken in 100 trap-nights by J. N. Layne. My own trapping in December, 1957, yielded 5 oldfield mice and 5 cotton rats in 50 trap nights.

Within two weeks after burning, Layne and J. V. Griffo trapped in the area. Twenty-eight traps on the burned section took 12 oldfield mice, 1 Florida deer mouse, 1 house mouse (*Mus musculus*), and 2 least shrews (*Cryptotis parva*). An additional 12 traps in the unburned portion of the field took 3 oldfield mice and 3 Florida deer mice. The house mouse and shrews were not recorded in previous or subsequent trapping. It is impossible to learn whether they had been living on the area and only became susceptible to trapping following the burn or had moved into the area following the burn. Both forms were taken in the center of the area, possibly indicating residence.

The results of trapping on the lines established following the burn are given in Table 1. The dissimilarity between the burned section and unburned is obvious. No cotton rats were taken in the burned section although they were taken along the fire break where the traps were set on the unburned side. There was no considerable difference in the catch of oldfield and Florida deer mice in the two sections, although a somewhat greater number were taken in the burned section. Of the 178 captures listed in Table 1, 118 were original captures, 60 recaptures. The recapture rate for the three species involved was nearly identical.

TABLE 1

TOTAL CAPTURES OF MAMMALS IN A LONGLEAF PINE-TURKEY OAK ASSOCIATION IN NORTH-CENTRAL FLORIDA FOLLOWING A MID-WINTER BURN.

Area	Species	Feb. 2-7	Feb. 16-20	March 12-16	April 15-19	May 29-June 2	Sept. 15-19	Totals	Percentage
Burn	*P. polionotus*	12	15	18	18	4	1	65	88
	P. floridanus	0	1	3	3	2	0	9	12
	S. hispidus	0	0	0	0	0	0	0	0
Fire-Break	*P. polionotus*	5	8	9	4	0	1	27	49
	P. floridanus	1	1	0	0	0	0	2	4
	S. hispidus	6	3	6	7	4	0	26	47
Unburned	*P. polionotus*	8	8	5	0	0	0	21	43
	P. floridanus	2	2	1	0	0	0	5	10
	S. hispidus	1	3	10	5	4	0	23	47
Totals (All species)		35	41	52	34	14	2	178	

Discussion

The effects of burning on game species has long received considerable attention from students of wildlife management. Stoddard (1931, 1935) has worked extensively on this aspect of quail management, and Leopold (1933) and O'Neil (1949) have shown the effects of fire on other economically important species. The effects of fire on the flora of the southeast has likewise been centered on economic forms, especially forest trees (Garren, *op. cit.*).

Considering the ecological importance and frequency of fire in the southeast, the lack of data on its effects on small mammals is surprising. Elsewhere, though studies are few, there are some data on the effect of fire on small mammal populations. Baker (1940), working in the Texas grasslands, stated that fire was detrimental to rodent populations, but based his conclusions on a restricted area and a small number of animals. Rice (1932) showed that deer mice (*P. maniculatus*) and meadow mice (*Microtus ochrogaster*) deserted a field of grass (*Panicum* sp., and *Poa* sp.) in Illinois following a prairie burn. Tevis (1956) showed that save for isolated areas not burned fires in coniferous forests in northwestern California completely destroyed resident rodent populations. Cook (1959) found that all species of mice were annihilated in a mixed brush and grassland area in the Berkeley Hills region of California.

In the present study there appeared to be no over-all disturbance of rodent populations in the burned area. The cotton rat, because of its affinity for dense, grassy cover, was the only species adversely affected. Cook (*op. cit.*) found that *Microtus* was slow to move back into a burned area for essentially the same reason. In this study oldfield mice and Florida deer mice did not appear to be affected. In general these latter mice are more frequently found in open, sandy areas so that such burns do not apparently cause a change in the habitat sufficient to result in movement of these rodents.

Further evidence that no great net change in population occurred is the similarity of the composition of catches made prior to burning, and the composite catch for the burned and unburned portions of the area during this study (Table 2). This seems to indicate the rodent population was not greatly affected over the whole area, but, rather, that the cotton rats moved from the burned to the unburned portions. The resultant differences in the populations were due to population shifts rather than mortality. Since all three species dealt with commonly reside in burrows and temperatures generated by field burning are not excessive; certainly not compared to the intensity of slash burning described by Tevis (*op. cit.*), it appears that there would be slight mortality from a burn in this habitat. The resultant changes in populations in a restricted area may result then from the flexibility of the forms involved to survive in an area following the burn. The observed changes in the population of the study area following the burn (Table 1) seem best explained by shifting populations rather than mortality.

TABLE 2

COMPARISON OF NUMBER OF RODENTS TAKEN FROM BURNED AND UNBURNED PORTIONS OF A LONGLEAF PINE-TURKEY OAK ASSOCIATION IN NORTH-CENTRAL FLORIDA PRIOR TO AND FOLLOWING A MID-WINTER BURN.

Species	Prior to Burning (150 trap-nights)	Percentage	After Burning (1800 trap-nights)	Percentage
P. polionotus	22	65%	113	63%
P. floridanus	1	3%	16	9%
S. hispidus	11	32%	49	28%
Totals	34	100%	178	100%

As was mentioned previously, the winter and spring of 1958 were unusually cold for this region (average minimum temperature was 36.1° F., whereas the 51 year average for the region during January and February is 47.9° F.). This apparently affected rodent populations and caused a poor spring breeding season, with a resultant lag in the seasonal build up of numbers. As early as May or June the cover in the burned area seemed dense enough to permit occupancy by cotton rats, although none was taken in the area. It is possible that under typical population levels the burned area would have been reoccupied by cotton rats within 6 months following the burn.

SUMMARY

The vegetative development following a mid-winter burn in a longleaf pine-turkey oak association is briefly traced. Unusually cold temperatures during the winter and spring of 1958 retarded plant growth for at least several weeks. Composites, dog fennel, and partridge pea were more common in the burned than the unburned portion of the study area. Wire-grasses formed the major

plant cover on the unburned section, but were removed from the burned section, and affected at least part of the rodent population.

Trapping in the burned and unburned sections indicated cotton rats moved from the burned to the unburned portions of the field following the burn whereas population densities of oldfield and Florida deer mice remained essentially at pre-burn levels. Comparison of trapping results, prior to and following the burn, indicated that, fire was not detrimental to the rodent populations over the whole area, but caused a shifting of populations after the fire as a result of change in the habitat.

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LITERATURE CITED

BAKER, ROLLIN H.

1940. Effects of burning and grazing on rodent populations. J. Mamm., 21(2) : 223.

COOK, S. F.

1959. The effects of fire on a population of small rodents. Ecology, 40(1): 102-8.

EMLEN, JOHN T., RUTH L. HINE, WILLIAM A. FULLER, and PABLO ALFONSO

1957. Dropping boards for population studies of small mammals. J. Wildl. Mgt., 21(3) : 300-314.

GARREN, K. H.

1945. Effects of fire on vegetation of the southeastern United States. Bot. Rev., 9(9) : 617-654.

HEYWARD, FRANK

1939. The relation of fire to stand composition of longleaf pine forests. Ecology, 20(2) : 287-304.

LAESSLE, ALBERT M.

1942. The plant communities of the Welaka area. U. Fla. Publ. Biol. Sci. Ser. 4(1) : 1-143.

LAY, DANIEL W.

1955. Effects of prescribed burning on forage and mast production in southern pine forests. Presented at 9th. Ann. Meeting, S. E. Assn. Game and Fish. Comm., 1-18 pp.

LEOPOLD, ALDO

1933. Game Management. New York: Scribner's Sons. 481 pp.

O'NEIL, TED

1949. The muskrat in the Louisiana coastal marshes. La. Dept. Wildl. Fish., New Orleans. 152 pp.

RICE, LUCILLE A.

1932. The effects of fire on the prairie annual community. Ecology, 13(4): 392-401.

SHEPHERD, W. O.

1953. Effects of burning and grazing flatwoods forest ranges. U. S. For. Serv., S. E. Exp. Sta. Res. Notes, No. 30, 2 pp.

SMALL, JOHN KUNKEL

1933. Manual of the southeastern flora. U. N. Carol. Press, Chapel Hill, 1554 pp.

STODDARD, HERBERT

1931. The bobwhite quail, its habits, preservation, and increase. New York: Scribner's Sons. 559 pp.

1935. Use of fire on southeastern game lands. Coop. Quail Study assoc. 19 pp.

TEVIS, LLOYD

1956. Effect of slash burn on forest mice. J. Wildl. Mgt., 20(4) : 405-409.

WAHLENBERG, W. G., S. W. GREENE and H. R. REED

1939. Effects of fire and cattle grazing on longleaf pine lands, as studied at McNeill, Mississippi. U.S.D.A. Tech. Bull., No. 683. 52 pp.

NORTHERN EXTENSIONS IN THE RECORDED RANGES OF PLANTS ON SEAHORSE AND ASSOCIATED KEYS, LEVY COUNTY, FLORIDA

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In making numerous trips to Seahorse Key during the years 1957 and 1958 we were aware of a number of species that seemed far north of their usual ranges. Mr. Erdman West was very helpful in making the Herbarium of the Florida Agricultural Experiment Station (henceforth referred to by FLAS) available and in checking determinations. Wharton's study (1958) supplied accurate records of the avifauna of the Islands and thus makes possible ample support for the probable mode of migration of seed of many plants including the unusually far north occurrence of certain species.

The climate of these Keys, Seahorse Key in particular, is considerably warmer than the adjacent mainland, or even Cedar Key, less than three miles away. The following minimum temperatures recorded during the severe cold wave of December 12 and 13, 1957 were: Seahorse 27° F., Cedar Key 25° F., Gainesville 16° F.

It has been noted (Wharton, *loc. cit.*) that most of the trees and shrubs on Seahorse Key bear edible fruits. While seeds of some trees could have been floated from the south by existing currents there is no reason to invoke this agency if bird dispersal provides a satisfactory explanation.

Although chance visitation of birds may result in seed dispersal on the Cedar Keys, of more importance would seem to be regular visits by birds common to the area. The most important are probably those which roost in great numbers on the islands or arrive in large flocks as transient winter visitors.

Ridley (1930) has documented the fact that seeds from fruiting trees pass through the digestive tracts of frugivorus birds in a relatively short time, between ½ to four hours, and that the passage leaves the seed unharmed. In fact, passage through the digestive tract of a bird apparently prepares the seed for speedy germination and enhances their possibility of survival.

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On the outer Cedar Keys, the fruits of *Tamala* (*Persea*), *Eugenia, Forestiera, Prunus, Chiococca, Capsicum, Bumelia, Sabal, Opuntia, Ilex, Amarolea (Osmanthus), Cerothamnus (Myrica), Batodendron* (*Vaccinium*), and *Callicarpa* are edible to birds, and most likely have been brought by this agency.

Of the birds roosting on the outer keys the Fish Crow, *Corvus ossifragus* Wilson, appear to be an important potential source of introduced seeds. Crows are not seen on Seahorse Key in any numbers until the rookeries begin to function in March. As has been pointed out by Wharton (1958) they roost by the thousands on nearby Snake Key and may be observed each evening crossing from the mainland in one continuous stream.

Fish Crows are known to devour the seeds of a number of the plants present on Seahorse and Snake Keys, although they roost in large numbers only on the latter island. The vegetation of these two neighboring islands is similar. A small grove of hackberries on Snake Key seems to be one of the chief differences between the vegetation of the two islands.

The vegetable food of the Fish Crow as listed by Bent (1946) consists of hackberries, pokeberries, red cedar, palmetto berries, magnolia, holly, red bay, catbrier, and dahoon. The Fish Crow and the American crow apparently differ chiefly in size. Ridley (*op. cit.:* p. 387) quotes from a paper by Kalmbach which states that the American Crows, *Corvus brachyrhynchos* (Brehm) frequently disgorge seed-containing pellets beneath roosts utilized between September and March. Bent (1946) discusses a roost discovered on the Potomac River in 1889, and estimated to contain 178 million seeds scattered on the 15 acres beneath it. Among these were seeds of *Rhus, Juniperus, Cornus, Nyssa sylvatica, Vitus, Celtis, Bumelia,* and *Smilax.* Ridley (*loc. cit.:* p. 456) states that the crow must be largely responsible for the distribution of many of the most common plants having drupe and baccate-type fruits.

An *Eugenia* occurs on Seahorse Key. Ridley (*loc. cit.:* p. 388) discusses the formation of new plantations of allspice, *Eugenia pimenta,* on Jamaica by frugivorus birds. Here, when area next to an existing plantation is cleared, the birds do the rest. Perhaps the cherry laurel thicket which occupies about ten acres on Seahorse Key has been formed by analagous means.

Robins, *Turdus migratorius* L., at least one other species of thrush, and waxwings, *Bombycilla cedrorum* Vieillot, seem to occur only in large winter flocks on the outer Cedar Keys.

Other birds common to the outer keys are Towhees, *Pipilo erythrophthalmus* L., Brown Thrasher, *Toxostoma rufum* L. and Catbirds, *Dumatella carolinensis* L.

Thrushes have been regarded as second only to pigeons as seed disseminators. Robins visit Seahorse Key in large aggregations during the winter (Wharton, 1958). Among the plants eaten by this fruit-eating bird and listed by Ridley (*loc. cit.:* p. 477), the following are of interest since most of them or similar species occur on the outer keys: *Juniperus, Sabal, Smilax, Myrica, Celtis, Morus, Phytolacca, Persea, Prunus, Rhus, Ilex, Vitis, Nyssa,* and *Vaccinium.* Sprunt (1954) notes that robins are known to devour 65 species of wild fruits.

Towhees and Brown Thrashers undoubtedly play some part in seed spreading in the Cedar Keys area for these birds are common on the outer keys and forage industriously in the leaf litter throughout the wooded parts of the islands. Acorns total 65% of the food of Brown Thrashers, according to Sprunt. Catbirds, *Dumetella carolinensis* L., are often seen on the Cedar Keys. This same author claims that 56% of the food of catbirds is berries and wild fruit.

While woodpeckers are not common to the outer Cedar Keys they are of possible importance in the establishment of some plants. On the mainland *Dryobates,* probably the Red-cockade Woodpecker, has been known to eat *Phytolacca, Vaccinium, Nyssa, Cornus, Prunus, Rhus,* and *Colaptes auratus* the Flicker, has been observed to devour *Smilax, Myrica, Prunus, Ilex cassine, Nyssa aquatica* and *Rhus radicans,* according to Ridley (1930). The Pileated Woodpecker, *Ceophloeus pileatus* L., has been observed on Seahorse Key. Sprunt (1954) records among its mainland foods: magnolia, tupelo, dogwood, poison ivy, sumac and hackberry.

The Grey Kingbird, *Tyrannus dominicensis* Gmelin, occurs regularly on the outer Cedar Keys and is supposedly fond of the berries of tropical trees and shrubs.

Acorns compose 43% of the diet of the Florida Blue Jay, *Cyanocitta cristata* (L.) and 34% of the diet of the Florida Jay, *Aphelocoma coerulescens* (Bosc.) according to Sprunt (*op. cit.*). These latter birds may have occurred on the islands from time to time.

Both jays are recorded from the mainland opposite the Cedar Keys, but are not often seen on the outer islands.

The storage habit of jays and some woodpeckers may more than offset their habit of chopping up acorns before swallowing them.

Some plants have doubtless reached the outer Cedar Keys by means other than having been deposited in bird feces. Some have floated there, notably the mangroves, and others are established riders on the wind or on furred and feathered hosts. Regarding flotation, Ridley states that some *Eugenia* may be dispersed short distances by water, but on the whole, the genus is bird or bat borne. He also states that *Sophora tomentosa* can float for an entire year and shares with *Canavalia* and *Erythrina* bouyancy afforded by light, tardily dehiscent pods.

Baccharis is an example of a wind-borne plant occurring on Seahorse Key. Other plants on the islands may be obviously borne by attachment. *Bidens* and *Plumbago* are in this group. *Plumbago* has a dense vine-like growth which covers the ground in rookery areas on both Snake and Seahorse Keys and is dispersed by the attachment of glandular, viscid hairs on the calyx to feathers, fur and feet.

The following plants are most noteworthy in extension of their known northern limits:

1. *Sophora tomentosa* L.

A single specimen of this plant was found and a branch collected by the senior author, FLAS No. 67617 on April 15, 1955 (See Fig. 1). This plant was growing just above the normal high tide mark on the sand spit at the east end of Seahorse Key. The same plant was observed in poor condition because of beach erosion, November 9, 1957. This plant was not present when the senior author visited the site in the early spring of 1959. It seems most likely that erosion rather than the severe cold of the winter of 1957-58 was responsible for its disappearance. Small (1933) states the range of this species in Florida to be "Southern peninsular Florida and the Keys". The FLAS closest records on the Gulf Coast, Pinellas County, about 80 miles to the south; on the East Coast, Merritts Island, Brevard County, about 50 miles south of Seahorse in latitude. Marine currents are almost certainly responsible for their transport, probably as individual seeds as Guppy (1917) reports they will float unharmed in sea water for several months.

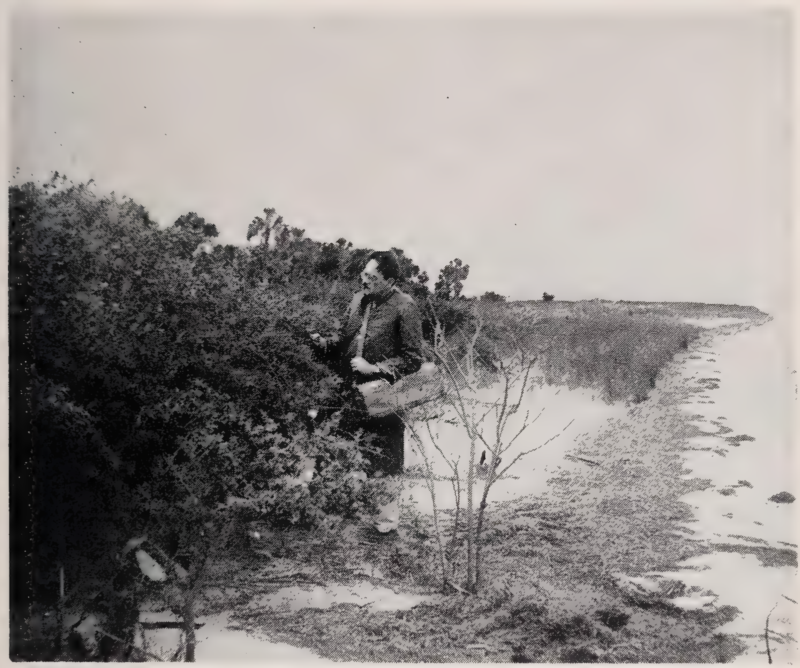

Figure 1. The nearly leafless shrub to the right of the figure is *Sophora tomentosa.* The dense thicket to the left is composed of *Bumelia angustifolia* and *Forestiera porulosa.* (Photo by Wharton, November 7, 1957).

2. *Forestiera porulosa* (Michx.) Poir.

This plant is quite abundant as a strand plant on Seahorse. Large specimens 8 to 10 feet high are common along the north shore near the "Rookery" Wharton (*op. cit.*) and on the sand spit at the east end of the Island. They suffered little or no damage from the severe winter of 1957-58. Small notes the range of this species as "Hammocks and sand dunes, S. Fla." FLAS collections as far north as Hillsborough County on the Gulf Coast and Brevard County on the Atlantic Coast, give *Forestiera porulosa* a northern range extension similar to that of *Sophora* above. Either birds or marine currents may have disseminated fruits of this species to Seahorse Key, the former seems much more likely.

3. *Bumelia angustifolia* Nutt.

This species forms dense thickets on the eastern sand spit of Seahorse with scattered plants along the north shore. It was also observed in abundance near the airstrip on Cedar Key. Efforts were made on numerous occasions during the past three years to observe its fruits, one of the more diagnostic characters of the species, but the severe winters of 1957-58 and 1958-59 had apparently killed all that may have started growth from the heavy bloom observed in the falls preceding these cold spells. However, its distinct mature bark characters checked with a specimen collected by the senior author on Key Largo, Florida. The length of the style was checked by Daniel Ward of the FLAS No. 73327. This character also fits *B. angustifolia.* The leaves of the Seahorse and Cedar Key specimens are more uniformly broad than those of most examples from further south. Small states the Florida range of this species to be, "coastal hammocks, S. pen. Florida." The FLAS contains one collection as far north as Pinellas County on the Gulf Coast but none further north than Dade County on the East Coast. No appreciable cold damage to the vegetative growth of this plant was observed. Dissemination of seed is doubtless by birds.

4. *Maytenus phyllanthoides* Benth.

While most abundant on the eastern sand spit of Seahorse, this species also occurs as scattered individuals just landward of the mangrove zone along much of the northern side of the island. Small states the range of this plant to be, "Hammocks and sand-dunes, coast of lower pen. Florida and Florida Keys. . . . " Its northernmost record on the Gulf Coast, based on collections in the FLAS, is Hillsborough County; on the East Coast only as far north as Palm Beach County. No injury to vegetative growth was observed after either of the cold winters and ripe fruits were frequently seen. Its fleshy fruits are probably distributed by birds.

5. *Conocarpus erecta* L.

A single specimen of this species was found by the junior author on Atsena Otie Key. This plant was a good 15 feet tall and with a number of stems with DBH of 4 inches were observed by the senior author November 7, 1957. A specimen, FLAS No. 73328 was collected at that time. Small notes the Florida range of this species as "Coastal hammocks and sandy shores, pen. Fla., Everglade Keys and Florida Keys." Northern records from the FLAS are Pinellas County on the Gulf side and Merritt's Island on the Atlantic coast. No knowledge as to the fate of this tree in the severe winters of 1957-58 and 1958-59 is available, but with as much cold damage to the other three mangrove species, *Rhizophora mangle* L., *Laguncularia racemosa* Gaertn. f. and *Avicennia nitida* Jacq. growing on Seahorse where all were killed back to large branches, it seems likely that this species suffered at least comparable damage. Marine currents are mainly responsible for the dispersal of this species. According to Guppy (1917) the seeds will float for several months in sea water and remain viable.

6. *Eugenia axillaris* (Sw.) Willd.

This species is abundant on many portions of Seahorse Key, particularly so near the central north shore and on the sand spit at the east end. Many specimens 10-12 feet tall are present which fruit abundantly. Small notes the range in Florida as, "Coastal hammocks, S. pen. Fla. and the Keys." The FLAS collection includes northern records from Pinellas, Hillsborough, Osceola Counties and Merritt's Island, Brevard County. Dissemination of seed is probably mainly through frugivorous birds. A number of inland records from the FLAS, Osceola, Highlands and Hendry Counties tend to support its avian dissemination. Fruits are commonly infected by galls which makes them much lighter than water and dispersal through marine currents also seems likely.

7. *Plumbago scandens* L.

This plant is frequent on the north shore of Seahorse in the "Rookery" Wharton (*op. cit.*). Small states its range in Florida as "Hammocks, S. Fla. and kitchen middens N. along the coasts." There is a considerable accumulation of large shells, perhaps a kitchen midden at the Seahorse locality. FLAS specimens of northernmost range are Manatee County on the Gulf, but a collection from near New Smyrna on the Atlantic side is nearly as far north as the Seahorse record. It seems likely that dispersal of this plant is mainly accomplished by the adhering of the hairy presistant calyces to the feathers of birds. Some cold damage to vegetative growth of this species was observed by the junior author.

8. *Guilandia crista* (L.) Small.

A small plant was observed in bloom at the eastern strand line of Seahorse Key. A specimen was collected November 10, 1957, FLAS No. 73321. Small lists the Florida range of this species as, "Low hammocks and coastal sand dunes, S. pen. Fla. and the Keys." FLAS records show northernmost collections from St. Petersburg, Pinellas County and Ormond, Volusia County on the East Coast, almost as far north as the Seahorse record. This plant appears to have, along with *Sophora tomentosa* above, been killed by erosion of the beach. Seed was probably transported by marine currents. Guppy (1917) reported that they will float for years and that they have reached Europe from the West Indies.

9. *Casuarina equisetifolia* Forst.

Although this tree has been planted extensively in the northern part of the peninsula it frequently suffers cold injury there. No records of its natural reproduction so far north have been observed by the senior author. Numerous mature planted trees are present on Cedar Key which are the nearest likely seed source for the score or so of young trees established on the sand fill near the N. E. point of Seahorse. This fill was formed in 1953 when a channel to the Marine Biological Station was dredged. The larger of those spontaneously established trees are 12-15 feet high, but had not by the spring of 1959, set any seed. However, as small seedlings less than a foot high are present, seed from the Cedar Key trees must fairly frequently be transported over the nearly three miles of intervening water. While the seeds of *Casurina* are winged it seems that water rather than wind is responsible for their dissemination to such a distance. Small gives the naturalized range of the species in Florida, "Sandy shores, pinelands, everglades and hammocks, S. pen. Fla., particularly S. of Miami and Keys." He also mentions that the tree is "Established in quite out of the way places through the agencies of wind and water." Reliable spontaneous records from the FLAS are known from Sanabel Island, Lee County on the Gulf Coast and Broward County on the Atlantic side.

All of the above northern extensions of range appear to be permanent except for the *Sophora* and *Guilandia* and possibly that of *Conocarpus*.

The reader must have been struck by the similarity of the northern records of many of the species both on the east and west coasts of Florida. This is no doubt in part due to the fact that warmer temperatures prevail near the sea than at corresponding inland latitudes. But the main factor influencing their distribution is doubtless the fact that all except the *Eugenia* are strand species.

Literature Cited

BENT, ARTHUR C.

1946. Life Histories of North American Jays, Crows, Titmice. USNM Bull. 191. (pp. 495)

GUPPY, H. B.

1917. Plants, Seeds, and Currents in the West Indies and Azores. Williams and Norgate, London. (pp. 531)

RIDLEY, HENRY N.

1930. The Dispersal of Plants Throughout the World, L. Reeve and Co., Ltd. Ashford, Kent, XX; 744 pp.

SMALL, JOHN K.

1933. Manual of the Southeastern Flora. Pub. by the author, N. Y., 1554 pp.

SPRUNT, ALEXANDER, JR.

1954. Florida Bird Life. Coward-McCann Inc., New York. (pp. 527)

WHARTON, CHARLES H.

1958. The Ecology of the Cottonmouths (*Agkistrodon piscivorus* Lacépéde) of Seahorse Key. Doctoral Dissertation (unpublished). University of Florida.

TWO NEW EYELESS OSTRACODS OF THE GENUS ENTOCYTHERE FROM FLORIDA

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The two new species described herein occur in the subterranean waters of the Florida peninsula on three albinistic crayfishes. In neither of these closely related ostracods is there a well defined eye, and it is doubtful that a trace of one is present. Both are close relatives of *Entocythere equicurva* Hoff (1944).

Only two studies of the ostracods of this genus in Florida have been published, and the most recent is that of Hart (1959). In this work he presented a key to the species known from Florida and the lower Chattahoochee-Flint basin, described two new species, and cited additional hosts and locality records for some of those that had been previously described by Hoff.

KEY TO THE OSTRACODS OF THE GENUS ENTOCYTHERE OF FLORIDA [1]

1 Clasping apparatus extends ventrally beyond ventral margin of distal portion of base of copulatory complex ---------- 2

1′ Distal portion of base extends much farther ventrally than does clasping apparatus ---------- 8

2(1) External border (fig. 1, EB) of clasping apparatus entire (figs. 2, 7-9, 14, 15, 17, 19, 20) ---------- 3

2′ External border of clasping apparatus with a talon or a distinct emargination (figs. 16, 18) ---------- 7

3(2) Internal border (fig. 1, IB) of clasping apparatus with a single tooth (occasionally an additional minute tooth present near junction of vertical and horizontal rami); if two prominent teeth present then vertical and horizontal rami are lying at approximately a right angle (figs. 7-9) 4

3′ Internal border of clasping apparatus with two or more prominent teeth; if only two, then clasping apparatus C-shaped (figs. 14, 15, 17) 5

4(3) Distal extremity of clasping apparatus with two teeth; distal portion of base without a prominent ridge (figs. 7-9) ---------- *E. lucifuga*, sp. nov.

4′ Distal extremity of clasping apparatus with three teeth; distal portion of base with a distinct ridge near anterodistal extremity (figs. 1, 2) ---------- *E. ambophora*, sp. nov.

5(3′) Internal border of C-shaped clasping apparatus with two teeth (fig. 17) ---------- *E. equicurva* Hoff (1944)

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[1] Modified from Hart (1959).

5′ Internal border of clasping apparatus with more than two teeth (figs. 14, 15) 6

6(5′) Clasping apparatus swollen at junction of two rami (fig. 14) .... *E. elliptica* Hoff (1944)

6′ Clasping apparatus not swollen at junction of two rami (fig. 15) .... *E. dorsorotunda* Hoff (1944)

7(2′) External border of clasping apparatus with two prominences (fig. 16) .... *E. talulus* Hoff (1944)

7′ External border of clasping apparatus with a distinct finger-like talon (fig. 18) .... *E. hobbsi* Hoff (1944)

8(1′) Extremity of distal portion of base bifurcate .... *E. torreya* Hart (1959)

8′ Extremity of distal portion of base blunt with an anterodorsally directed angular prominence .... *E. geophila* Hart (1959)

ENTOCYTHERE AMBOPHORA [2], sp. nov.

Male.—Shell (fig. 5) subovate with posterior portion slightly higher than anterior; margins entire, lacking emarginations and spines, with a few widely dispersed submarginal setae on valves. The shell size (in mm.) of 10 specimens follows.

Length	Height	Length/Height
0.305	0.170	1.79
0.305	0.175	1.74
0.305	0.170	1.79
0.310	0.170	1.82
0.305	0.160	1.91
0.310	0.165	1.88
0.305	0.160	1.91
0.305	0.160	1.91
0.310	0.160	1.94
0.310	0.160	1.94

Mandible (fig. 6) entirely similar to that of *E. daphnioides* Hobbs (1955: 328) except distal seta on penultimate podomere extends distally almost to tip of terminal setae, and large terminal scoop-like seta on ultimate podomere not so heavy.

Maxilla (fig. 3) also similar to that of *E. daphnioides* except palp lacking seta on convex dorsal surface; although, emargination present opposite level of distal end of protopodite.

Copulatory complex (figs. 1, 2), except for lacking a finger guard, consisting of the usual elements. Distal portion of base with a

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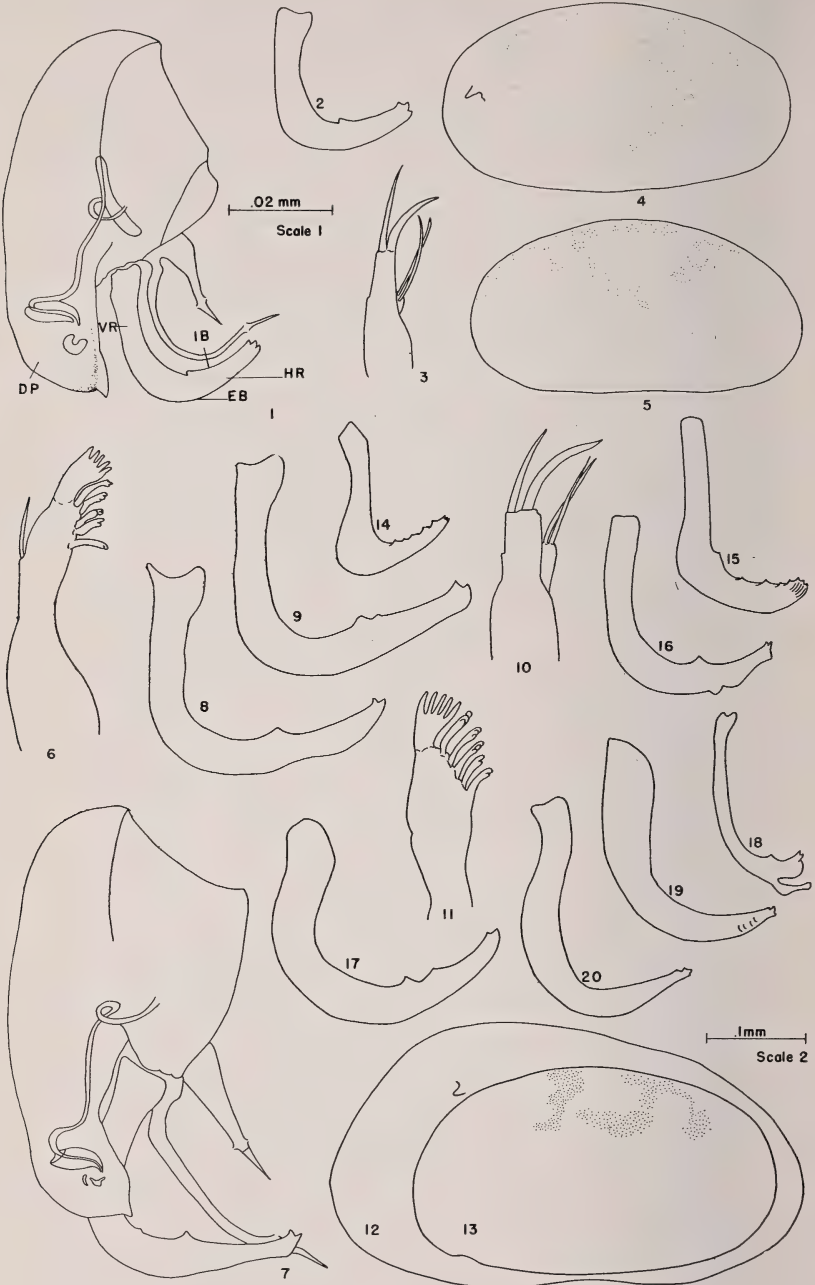
[2] *Ambon* G.—raised border or rim; *phorus* G.—to bear. Name chosen because of ridge on distal portion of base of copulatory complex.


DP
VR
IB
HR
EB
.02 mm
Scale 1
.1mm
Scale 2

distinct ridge along cephalodistal margin that terminates in an acute spine. Distal and proximal portions of base not clearly distinguishable. Horizontal and vertical rami of clasping apparatus merge imperceptibly; distal extremity of latter ramus with three teeth, external border entire, and internal border with a single tooth.

Female.—Shell of triunguis female (fig. 4) similar to that of male but larger. Third claw on antenna apparently frequently vestigial or absent. A small papilla near posterior extremity of body but no ruffled skirt or J-shaped rod. Shell size (in mm.) of 10 specimens follows.

Length	Height	Length/Height
0.350	0.180	1.94
0.350	0.185	1.89
0.350	0.210	1.67
0.355	0.190	1.87
0.340	0.185	1.84

EXPLANATION OF PLATE [3]

Abbreviations

DP—distal portion of base
EB—external border
HR—horizontal ramus
IB—internal border
VR—vertical ramus

Fig. 1. Copulatory complex of *E. ambophora.*
Fig. 2. Clasping apparatus of *E. ambophora.*
Fig. 3. Maxilla of *E. ambophora.*
Fig. 4. Right valve of shell of female *E. ambophora.*
Fig. 5. Right valve of shell of male *E. ambophora.*
Fig. 6. Mandible of *E. ambophora.*
Fig. 7. Copulatory complex of *E. lucifuga.*
Figs. 8 and 9. Clasping apparati of *E. lucifuga.*
Fig. 10. Maxilla of *E. lucifuga.*
Fig. 11. Mandible of *E. lucifuga.*
Fig. 12. Right valve of shell of female *E. lucifuga.*
Fig. 13. Right valve of shell of male *E. lucifuga.*
Figs. 14-20. Clasping apparati (after Hart, 1959).
Fig. 14. *E. elliptica.*
Fig. 15. *E. dorsorotunda.*
Fig. 16. *E. talulus.*
Fig. 17. *E. equicurva.*
Fig. 18. *E. hobbsi.*
Fig. 19. *E. torreya.*
Fig. 20. *E. geophila.*

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[3] Figs. 4, 5, 12 and 13 drawn to *scale 2*; Figs. 1-3 and 6-11 drawn to *scale 1*.

Length	Height	Length/Height
0.360	0.190	1.89
0.350	0.195	1.79
0.345	0.190	1.82
0.330	0.180	1.83
0.340	0.185	1.84

Smaller biunguis female readily distinguished from triunguis female by undivided penultimate podomere of antenna.

Type Locality.—Palm Springs, Seminole County, Florida. The host is *Procambarus acherontis* (Lönnberg). No other ostracods or crayfishes were taken from this spring (see Hobbs, 1940: 388). This ostracod is known only from the type locality.

Disposition of Types.—The holotype, allotypic triunguis female, morphotypic biunguis female, and a dissected male paratype are deposited in the United States National Museum. Paratypes are in the collections of Mr. E. A. Crawford and the junior author.

Relationships.—*Entocythere ambophora* has its closest affinities with members of the Columbia group (see revised definition in Hart, 1959: 203), and is most closely allied to the species described below. This affinity is most clearly seen in the form of the distal portion of the base of the copulatory complex. It may be distinguished from all other members of the genus by the following combination of characters: clasping apparatus C-shaped with a single tooth on internal border and with three terminal teeth; distal portion of base with a prominent ridge along anterodistal border that distally is produced into a spine; eyes absent.

ENTOCYTHERE LUCIFUGA [3], sp. nov.

? *Entocythere equicurva* Hoff, 1944: 340 (in part)

Hoff (*loc. cit.*) reported the presence of *E. equicurva* on several crayfishes in Florida, Georgia, and Alabama and listed *Procambarus lucifugus alachua* (Hobbs) as one of the hosts. It seems probable that this host record should be for *Entocythere lucifuga.* Although this ostracod is closely allied to *E. equicurva* it may be distinguished from the latter by the absence of eyes, the apparent larger size, and the usually fewer teeth along the internal border of the clasping apparatus.

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[3] Lucifugus L.—shunning the light. Name chosen because of the subterranean habitat of this ostracod.

With the following exceptions the description given for *E. ambophora* applies to *E. lucifuga.*

Male.—Shell (fig. 13) subovate with a slight emargination, sometimes absent, near posteroventral extremity. The shell size (in mm.) of nine specimens follows.

Length	Height	Length/Height
0.390	0.210	1.86
0.365	0.195	1.87
0.350	0.200	1.75
0.360	0.195	1.85
0.360	0.195	1.85
0.360	0.195	1.85
0.390	0.200	1.95
0.370	0.200	1.85
0.360	0.200	1.80

Copulatory complex (figs. 7-9) similar to that of *E. ambophora* but distal portion of base without a ridge on anterodistal margin and clasping apparatus with two terminal teeth; internal border with one or more teeth.

Female.—Shell of triunguis female (fig. 12) conspicuously higher posteriorly than that of male, and ventral margin with a distinct concavity slightly anterior to midlength.

The shell size (in mm.) of the only triunguis females available follows.

Length	Height	Length/Height
0.420	0.250	1.68
0.425	0.250	1.70
0.415	0.220	1.89
0.410	0.235	1.74

Shell of biunguis female similar to that of triunguis form, but lacking concavity on ventral margin; anterior portion proportionately higher.

Type Locality and Range.—Hog Sink, about 13 miles west of Gainesville, Alachua County, Florida (see Hobbs, 1942: 138). The host is *Procambarus lucifugus alachua* (Hobbs). Specimens of *E. lucifuga* were found on *P. pallidus* from Squirrel Chimney, 12.5 miles northwest of Gainesville.

Disposition of Types.—The holotype, allotypic triunguis female, morphotypic biunguis female and a dissected male paratype are deposited in the United States National Museum. Paratypes are in the collection of Mr. E. A. Crawford and the junior author.

Relationships.—*E. lucifuga* is more closely related to *E. ambophora* than to any described species, although it has much in common with *E. equicurva.* It may be distinguished from all other species by the following combination of characters: clasping apparatus with one or two teeth on internal border and two terminal teeth; eyes lacking.

LITERATURE CITED

HART, C. W., JR.

1959. The ostracods of the genus Entocythere from the Lower Chattahoochee-Flint Basin: with a review of the occurrence of the genus in Florida, and descriptions of two new species. Bull. Fla. St. Mus., Biol. Sci., 4(6): 193-204, 19 figs.

HOBBS, HORTON H., JR.

1940. Seven new crayfishes of the genus Cambarus from Florida, with notes on other species. Proc. U. S. Nat. Mus., 89(3097): 387-423, 22 figs.

1942. The crayfishes of Florida. Univ. Fla. Pub., Biol. Sci. Series, 3(2): 1-179, 3 text figs., 11 maps, 2 pls.

1955. Ostracods of the genus Entocythere from the New River system in North Carolina, Virginia, and West Virginia. Trans. Amer. Micros. Soc., 74(4): 325-333, 10 figs.

HOFF, C. CLAYTON

1944. New American species of the ostracod genus Entocythere. Amer. Midl. Nat., 32(2): 327-357, 33 figs.

PROTOZOAN FAUNA OF A LIMESTONE SINKHOLE IN NORTH-CENTRAL FLORIDA

Douglas A. Rossman
University of Florida

The protozoan fauna of the Devil's Mill Hopper, a deep limestone sinkhole located in R19E, T9S, Section 15 in Alachua County, has not been reported previously. The Mill Hopper, which is near the center of a mesic hammock surrounded by turkey oak-pine flatwoods, is approximately 115 feet deep with steep, but well-vegetated, slopes from which numerous small springs issue about one third of the way down the slope. The flow from the springs tumbles down over exposures of Hawthorn limestone to a pool which was approximately 50-75 feet in diameter at the time of this study. The pool is bordered during low water levels by low banks of accumulated silt. The springs and their runs are virtually devoid of conspicuous organic matter; the pool under average conditions has a moderate amount of algae around its margin as well as a number of aquatic invertebrates and small fish. In addition to the main spring runs, a much smaller volume of water trickles down over the rocks adjacent to the runs and subsequently over the large number of liverworts (*Dumortiera hirsutum*) and mosses (Amblystegium group of the family Hypnaceae) which are growing on them.

Materials and Methods

Water samples were taken from three different microhabitats in order to increase the comprehensiveness of the survey and to allow for ecological comparisons. Where possible a small amount of the detritus was collected with the water. Water temperature was measured with a Taylor fishing thermometer; pH was approximated with a Taylor colorimetric pH indicator. The first sample was obtained November 16, 1958, from a spring run about 3 feet from the point where it emerges from the hillside. No aquatic vegetation was present. The water temperature was 69° F; the pH was slightly basic.

The second sample was also collected November 16, 1958. It consisted of a sample of the liverworts and mosses previously mentioned plus some of the substrate. These were partially immersed in water obtained by placing the jar beneath a liverwort over which water was trickling. Neither water temperature nor pH were determined.

The last sample was taken from the edge of the pool on January 4, 1959. Due to flooded condition following heavy rain, it was impossible to obtain a bottom sample. The water temperature was 67° F; the pH was slightly basic.

The samples were examined approximately twice a week from November 18 until December 11, 1958, and from January 6 to January 13, 1959. Species identifications were made by means of reference to Hall (1953), Hoogenraad and deGroot (1940), Jahn (1949), Kahl (1935) and Kudo (1954).

The writer is most grateful to Dr. E. C. Bovee for assistance in identifying the protozoa; and to Dr. E. S. Ford who kindly identified the associated bryophytes.

Results

Forty-three forms of protozoa were identified at least to genus and in most cases to species. These represent 16 mastigophorans, 8 sarcodinans, and 19 ciliophorans. No sporozoans were present in the samples. In the following list of species (S) indicates presence in the spring run, (L) indicates presence on the liverworts and mosses, and (P) indicates presence in the pool.

Subphylum Mastigophora

Monas guttula Ehrenburg (P); *Monas* sp. No. 1 (L); *Monas* sp. No. 2 (S).
Oikomonas termo Lemmermann (P) 5-6 μ.
Cyathomonas truncatum Ehrenburg (S).
Astasia longa Pringsheim (L): *A.* cf. *dangeardi* Lemmermann (L) 25μ; *A. torta* Pringsheim (L); *Astasia* sp. No. 1 (L) 22-31μ; *Astasia* ? sp. No. 2 (L) 5μ.
Entosiphon sulcatum Dujardin (S).
Bodo caudatus Dujardin (S); *B. edax* Klebs (S); *B. minima* Klebs (S).
Pleuromonas jaculans Perty (P).
Retortomonas ? sp. No. 1 (L).

Subphylum Sarcodina

Acanthamoeba ? sp. (L)[1].
Centropyxis constricta Ehrenberg (S, L) 30-112μ; *C. platystoma* Penard (L) 70μ, *Difflugia oblonga* Ehrenburg (L); *D. globulosa* Dujardin (L) 34μ; *D.* cf. *curvicaulus* Penard (L) 56μ. *Trigonopyxis arcula* Leidy (L) 33μ. *Trinema lineare* Penard (L) 36μ.

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[1] Represented by a cyst 8μ in diameter.

Subphylum Ciliophora

Chilodonella turgidula Penard (P) 30μ; *C. caudata* Stokes (P).
Coleps nolandi Kahl (S).
Paramecium nephridiatum von Gelei (L); *P. trichium* Stokes (L).
Trichopelma sphagnetorum Levander (L).
Homalogastra setosa Kahl (L) 17μ. *Malacophrys rotans* Kahl (S).
Tetrahymena pyriformis Ehrenburg (S); *Tetrahymena* sp. No. 1 (S); *T. vorax* Kidder, Lilly, and Claff (L)[2] 30.
Philaster ? sp. No. 1 (L).
Ctedoctema acanthocrypta Stokes (L) 20μ. *Cyclidium* sp. No. 1 (L)[3] 22μ.
Metopus sp. No. 1 (P).
Aspidisca sp. No. 1 (L).
Holosticha sp. No. 1 (P). *Oxytricha* ? sp. No. 1 (S).
Vorticella sp. No. 1 (L).

In addition the liverwort-moss sample contained a small (15μ) unidentifiable ciliate which possessed a prominent "gullet" and lateral groove.

Discussion

There are three striking features about the protozoan fauna of the Mill Hopper: (1) the distinct differences in the composition of the population for the three microhabitats, *Centropyxis constricta* being the only species found in more than one (the genus *Monas* was present in all three samples but was represented by a different species in each); (2) the small size of the great majority of individuals; (3) and the very low population density. The first two features are noted under Results; the latter is discussed below. The ecological data gathered was insufficient to postulate the underlying causes.

Population density is expressed here as an index in terms of individuals per slide examined (I/S). Population density was lowest in the spring run sample. *Entosiphon* and *Bodo minima* were the most abundant species, appearing about once every three slides examined (I/S = .33). The two other species of *Bodo* had an index of .13, and the remaining eight species were observed only once (.07).

Astasia longa (17.8) and *Cyclidium* were extremely abundant in the liverwort-moss sample. Approximately half a dozen *Cyclidium* were visible in the microscopic field at all times, the great number involved rendering an index impractical. Other indices in order of decreasing abundance were: *Paramecium nephridiatum,* .44; *P. trichium* and *Difflugia globulosa,* .33; *Centropyxis constricta,* .22; and the remainder, .11.

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[2] Saprozoic form.

[3] Observed actively ingesting bacteria. One individual was undergoing cell division.

Oikomonas (3.7) and *Chilodonella caudata* (2.1) predominated in the pool sample. Each of the five other species had an index of .14.

Future investigations should concentrate on developing techniques for discovering the nature of the ecological dissimilarities of the different microhabitats.

LITERATURE CITED

HALL, R. P.
1953. Protozoology. Prentice-Hall, New York.

HOOGENRAAD, H., and A. A. DEGROOT
1940. Zoetwaterrhizopoden en Heliozoen, in Boschma, H.: *Fauna van Nederland,* 9:1-303. Sijthoff, Leiden.

JAHN, T. L., and F. F. JAHN
1949. How to Know the Protozoa. W. C. Brown, Dubuque, Iowa.

KAHL, A.
1935. Urtiere oder Protozoa, 1: Wimpertiere oder Ciliata (Infusoria), in Dahl, F.: *Die Tierwelt Deutchlands,* 1-886. Fischer, Jena.

KUDO, R. R.
1954. Protozoology, 4th Ed. C. C. Thomas, Springfield, Illinois.

FOUR TREMATODES FROM THE BLACK SKIMMER, *RYNCHOPS NIGRA* LINN., (AVES: RYNCHOPIDAE), IN GASPARILLA SOUND, FLORIDA, INCLUDING THE DESCRIPTION OF A NEW GENUS AND TWO NEW SPECIES[1]

Franklin Sogandares-Bernal[2]
Florida State Board of Conservation Marine Laboratory

The trematodes reported here were collected from Black Skimmers in Little Gasparilla Pass, Gasparilla Sound, Florida.

Galactosomum spinetum (Braun, 1901) and *Stephanoprora denticulata* (Rudolphi, 1802) were also taken from these same birds. S. *denticulata* has apparently been reported from the West Coast of Florida only in the Herring Gull, *Larus argentatus* Linn. (Hutton & Sogandares, *in press*).

This study was sponsored by the Florida State Board of Conservation in connection with a continuing research program dealing with the parasites and diseases of coastal animals from Florida.

Acknowledgments are here extended to Dr. Eugenie Clark, Director, Cape Haze Marine Laboratory, for making certain facilities available in the Gasparilla Sound area; to Professor W. E. Martin, University of Southern California, for reading the manuscript; and to Professor R. M. Cable, Purdue University, for so graciously having examined the type material, making suggestions, and for furnishing sketches and other unpublished details which were valuable in the interpretation of the terminal genitalia of my material.

Unless otherwise stated, all measurements are in millimeters.

NEOSTICTODORA HUTTONI, n. sp., n. gen.

Host:	*Rynchops nigra* Linn.; skimmer; family Rynchopidae
Location:	Intestine
Locality:	Little Gasparilla Pass, Gasparilla Sound, Florida
Holotype:	U. S. Nat. Mus. Helm. Coll. No. 39202

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[1] Contribution Number 34 from The Fla. State Board of Consv. Marine Lab., Maritime Base, Bayboro Hrbr., St. Petersburg.

[2] Present address: Zoology Department, Tulane University.

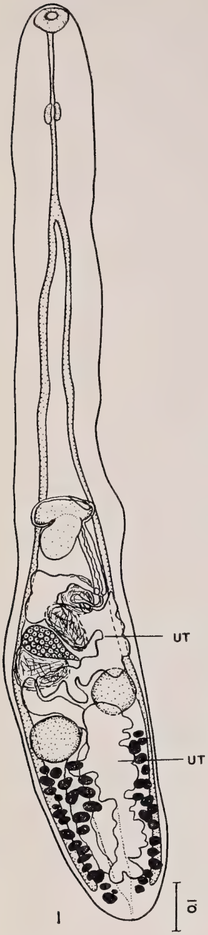
Diagnosis (based on 2 specimens): Body elongate and narrow, widest at postequatorial level, 1.580 to 1.700 long by 0.238 to 0.255 in maximum width. Cuticle spined to posterior end of body. "Eyespots" of diffuse granules present on each side of pharynx. Oral sucker subterminal, 0.048 to 0.052 long by 0.060 to 0.060 wide. Acetabulum (Fig. 2) median and postequatorial, about 0.100 to 0.104 wide; bilobed with about 100 coarse spines approximately 8 microns long on each lobe. Prepharynx 0.128 to 0.136 long, 2.65 to 3.40 times length of pharynx. Pharynx 0.040 to 0.048 long by 0.028 to 0.028 wide. Esophagus 0.188 to 0.196 long, about 3.92 to 4.90 times length of pharynx. Cecal bifurcation 0.420 to 0.424 from anterior end of body. Ceca 2, one on each side of body; ending blindly in posterior tip of body.

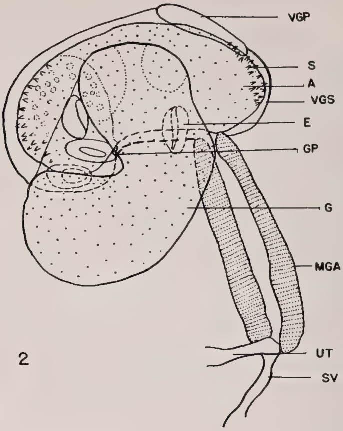
Ventrogenital pore postequatorial, intercecal; followed by ventrogenital sac enclosing acetabulum posterodorsally and medially, and about anterior ½ of a ventral gonotyl which is about 0.128 to 0.136 long. Portion of gonotyl within ventrogenital sac seeming to fuse with anteromedian and ventral surface of unspined section of acetabulum; portion of gonotyl outside ventrogenital sac bulbular in shape. Testes 2, oblique, about in posterior ⅘ body, intercecal; subspherical in shape, smooth in outline; sinistral testis foremost, 0.096 to 0.100 long by 0.080 to 0.080 wide; dextral testis posteriormost, 0.100 to 0.120 long by 0.096 to 0.100 wide. Posttesticular space 0.306 to 0.306 long. Seminal vesicle tripartid, the apposed muscular tip almost in contact with ovary; connecting with a muscular genital atrium about 0.084 to 0.108 long which lacks muscles previous to entering ventrogenital sac at base of right acetabular lobe. Prostate cells surrounding seminal vesicle or other genital ducts apparently lacking. Ovary dextral, intercecal, between testes and acetabulum, subtriangular to oval in shape, with smooth borders; 0.068 to 0.080 long by 0.080 to 0.100 wide. Seminal receptable immediately posterior to ovary; with posterior border almost in line with foretestis. Vitellaria filling most of posttesticular space behind each testis. Uterus descending from ovary to fill posttesticular space, ascending between testes, filling space between ovary and testes and ovary and acetabulum, inserting into genital atrium together with seminal vesicle. Eggs 20 to 24 microns long by 12 microns wide. Excretory vesicle not clearly observed.

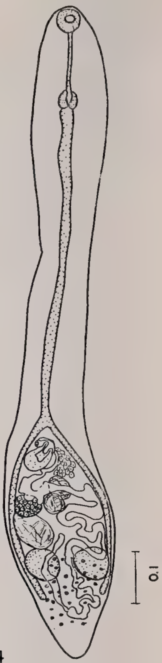
The name *huttoni* is in honor of my colleague, Dr. R. F. Hutton.

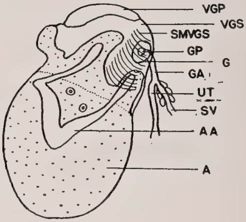
Discussion: *Neostictodora huttoni* differs from all other described species of *Stictodora*, and other genera of the Stictodorinae, by possessing a muscular genital atrium connecting the seminal vesicle and uterus with the ventrogenital sac. Other outstanding features are the bilobed and spined acetabulum which is seemingly fused with the gonotyl. The male and female ducts of *Stictodora* spp. usually open directly into the ventrogenital sac, or into a short non-muscular genital atrium. A fusion of the two genital ducts leading to the ventrogenital sac or extension of existing genital atrium with subsequent muscularization could produce a condition such as found in *Neostictodora*. Presently I prefer to regard the presence of a muscular genital atrium as a generic character in this group of trematodes. Thus I propose the genus *Neostictodora* which is like *Stictodora* Looss, 1899, but differs by possessing a muscular genital atrium connecting the seminal vesicle and uterus with the ventrogenital sac. Additional characters are the bilobed and spined acetabulum with a seemingly fused portion of gonotyl lying in the ventrogenital sac.

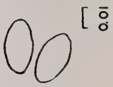
Professor Raymond Cable (personal communication) has made histological studies of the terminal genitalia of certain heterophyid trematodes. He has established a terminology which reflects the homology of the terminal genital ducts of heterophyids with that of other trematodes. His terminology is used in this paper and is as follows: The ventrogenital pore is the aperture of the ventral surface of the body which connects with the ventrogenital sac, a cavity that contains a portion of the acetabulum, gonotyl and genital pore. The acetabulum is a highly modified structure and is usually the posterocentral spine-bearing muscular structure which partially intrudes into the ventrogenital sac. The gonotyl is usually on the left side of the ventrogenital sac, being in essence a muscular pad or muscular thickening of the wall of the ventrogenital sac. The genital pore is the aperture of the uterus and seminal vesicle into the ventrogenital sac. Since *Neostictodora* possesses an additional character, a highly muscular hermaphroditic duct connecting the seminal vesicle and uterus with the ventrogenital sac, Professor Cable suggests that the structure be called a genital atrium in order to maintain a homologous terminology with that used for other trematodes.

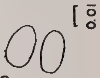












EXPLANATION OF FIGURES

Unless otherwise specified all drawings were made with the aid of a camera lucida. The projected scales are in millimeters. Abbreviations used: A, acetabulum; AA, acetabular armature; E, egg; G, gonotyl; GA, genital atrium; GP, genital pore; MGA, muscular hermaphroditic duct or genital atrium; S, spine; SMVGS, spiral musculature of ventrogenital sac wall; SV, seminal vesicle; UT, uterus; VGP, ventrogenital pore; VGS, ventrogenital sac.

Fig. 1. *Neostictodora huttoni* (this paper), ventral view.
Fig. 2. Same. Sketch of terminal genitalia, ventral view.
Fig. 3. Same. Uterine eggs.
Fig. 4. *Stictodora (Parastictodora) martini.* Ventral view.
Fig. 5. Same. Sketch of terminal genitalia, ventral view.
Fig. 6. Same. Uterine eggs.

STICTODORA (PARASTICTODORA) MARTINI, n. sp.

(Figs. 4 to 6)

Host:	*Rynchops nigra* Linn.; skimmer; family Rynchopidae
Location:	Intestine
Locality:	Little Gasparilla Pass, Gasparilla Sound, Florida
Holotype:	U. S. Nat. Mus. Helm. Coll. No. 39203

Diagnosis (based on 3 specimens, measurements on 2 favorable specimens): *Stictodora* (*Parastictodora*): Body elongate, narrow, widest at level of genital organs, 1.19 to 2.142 long by 0.187 to 0.204 in maximum width. Forebody 0.782 long. "Eyespots" of diffuse granules present on each side of pharynx. Cuticle spined to posterior end of body. Oral sucker subterminal, 0.044 to 0.048 long by 0.048 to 0.056 wide. Acetabulum median, and in posterior ⅓ body, bulbular in shape, 0.080 to 0.084 long by 0.056 to 0.060 wide; containing a U-shaped sclerotized armature (sinistral, dextral and basal portions of armature measure about 44 to 48, 40 to 44 and 36 microns respectively) embedded in its matrix; tips of armature anterior and covered with muscular tissue; also containing giant cells such as described for *Parastictodora hancocki* Martin, 1950. Prepharynx from 0.096 to 0.104, about 3 times length of pharynx. Pharynx 0.032 to 0.040 long by 0.028 to 0.032 wide. Esophagus 0.493 to 0.595 long, about 12 to 18 times length of pharynx. Cecal bifurcation about 0.784 to 0.782 from anterior end of body. Ceca 2, extending one on each side of body to end blindly about ⅔ distance from acetabulum to posterior end of body, a short distance behind testes.

Ventrogenital pore median, immediately behind cecal bifurcation, followed by a ventrogenital sac posteromedially enclosing anterior portion of acetabulum which contains tips of U-shaped armature; and a gonotyl on sinistral side of ventrogenital sac wall. Spiral muscular fibers which appear as parallel striations on dextroventral wall of ventrogenital sac, extending from anterior border of gonotyl to level of acetabular insertion into the ventrogenital sac, probably representing a muscular thickening of the ventrogenital sac wall. A thickening on sinistral side of ventrogenital sac appears to fuse with acetabulum and may represent a vestige containing a rudimentary third sclerotized prong of the acetabular armature. Testes 2, side by side, behind middistance from cecal bifurcation to posterior end of body, intercecal, roundish in shape and smooth in outline; dextral testis (measurable in a single specimen) 0.060 long by 0.056 wide; sinistral testis (measurable in a single specimen) 0.068 long by 0.056 wide. Posttesticular space 0.102 to 0.153 long. Seminal vesicle bipartid, median between acetabulum and testes, opening into a short non-muscular genital atrium which appears to penetrate gonotyl, opening into ventrogenital sac through genital pore. Prostate cells surrounding portion of seminal vesicle proximal to ventrogenital sac. Ovary dextral, intercecal, between acetabulum and dextral testis; roundish in shape and smooth in outline; 0.048 to 0.068 long by 0.044 to 0.064 wide. Seminal receptacle immediately postovarian, in contact with ovary and dextral testis. Vitellaria mainly intercecal in posttesticular space, at least overlapping posterior ½ testes. Uterus descending from ovary to a point about midway between testes and posterior end of body, ascending intertesticularly, occupying space between ovary, testes and acetabulum to enter genital atrium on left side of seminal vesicle. Uncollapsed uterine eggs 20 to 24 microns long by 12 microns wide. Excretory vesicle not observed.

The name *martini* is in honor of Professor W. E. Martin, University of Southern California, in recognition of his life-history studies of the heterophyids.

Discussion: There is one other species in the sub-genus *Parastictodora* Martin, 1950. This species, S. (*P.*) *hancocki* (Martin, 1950), was obtained experimentally in chickens. S. (*P.*) *martini* differs from S. (*P.*) *hancocki* as follows: Spiral muscular fibers present in ventral left wall of ventrogenital sac, ceca ending a short distance posterior to testes, cecal bifurcation almost in posterior ⅔ body, seminal receptacle posterior to ovary and eggs 20 to 24 microns long by 12 microns wide, as compared with ventrogenital sac without spiral muscular fibers, ceca extending to posterior end of body, cecal bifurcation almost equatorial and eggs 25 to 28 microns long by 13 to 16 microns wide. Yamaguti (1958), though not Morozov (1953), would relegate *Parastictodora* to sub-generic rank in the genus *Stictodora*. I am not in complete agreement with Yamaguti (1958). My specimens of *P. martini* were instantly recognizable as belonging to the sub-genus *Parastictodora* on the basis of possessing an unspined acetabulum with a sclerotized U-shaped armature and a very long esophagus. These characters make S. (*P.*) *hancocki* and S. (*P.*) *martini* very distinctive. Another view is that the rudimentary portion of the acetabulum on the dextral side of the ventrogenital sac of S. (*P.*) *martini* may contain a vestigial third prong of the sclerotized armature of the acetabulum. Due to insufficient material, I have not sectioned specimens to ascertain this point. If a reduction of size of the third acetabular prong occurs in my material, it would represent an intermediate condition between species of *Stictodora* and *Parastictodora hancocki* Martin, 1950. In this case, the only remaining character to separate *Stictodora* from *Parastictodora* would seem to be the length of the esophagus. This latter character could hardly be considered generic in value. Pending new collections and a study of additional material, Yamaguti's (1958) views concerning *Parastictodora* shall be retained with the above cited qualifications. Martin (1950) and Martin and Kuntz (1955) have studied the life histories of a species each of *Parastictodora* and *Stictodora*, respectively, and have found the cercariae to be very similar.

SUMMARY

Neostictodora huttoni (this paper), *Stictodora* (*Parastictodora*) *martini* (this paper), *Galactosomum spinetum* (Braun, 1901) and *Stephanoprora denticulata* (Rudolphi, 1802) are reported from the Black Skimmer, *Rynchops nigra* Linn. (Aves: Rynchopidae), for the first time in the west coast of Florida. A new genus, *Neostictodora* is proposed. *Neostictodora* is like *Stictodora* but differs by possessing a muscular genital atrium connecting the uterus and seminal vesicle with the ventrogenital sac. In addition, the acetabulum within the ventrogenital sac is bilobed and spined and the gonotyl is ventral and appears to be fused with the acetabulum.

LITERATURE CITED

HUTTON, R. F., and F. SOGANDARES-BERNAL

In press. Studies on helminth parasites from the coast of Florida. II. Digenetic trematodes from shore birds of the west coast of Florida. 1. Bull. Mar. Sci. Gulf and Carib.

MARTIN, W. E.

1950. *Parastictodora hancoki* n. gen., n. sp. (Trematoda: Heterophyidae), with observations on its life cycle. J. Parasitol., 36(4): 360-370.

1955. Some Egyptian heterophyid trematodes. J. Parasitol., 41(4): 374-382.

MOROZOV, F. N.

1953. Superfamily Heterophyoidea Faust, 1959. (In Skrjabin, K. J., Trematodes of Man and Animals, 6: 153-584, Movska, Leningrad) (In Russian).

YAMAGUTI, S.

1958. Systema Helminthum. Vol. I. The Digenetic Trematodes of Vertebrates. Parts 1 and 2. Interscience Publishers, Inc., New York.

RESEARCH NOTE

REVALUATION OF THE PLEISTOCENE *UROCYON SEMINOLENSIS* FROM FLORIDA

Several mandibular fragments with associated teeth found at Seminole Field, Pinellas Co., Florida, were described as an extinct fox (*Urocyon seminolensis*) by (Simpson, 1929, Bull. Amer. Mus. Nat. Hist. 56(8): 561-599). The diagnostic characters were the length (54 mm. from posterior end of canine alveolus to posterior edge of alveolus for M_3) and certain molar characters.

Examination of a series of mandibles of Recent *Urocyon cinereoargenteus* reveals that each of the characters of *U. seminolensis* is easily reproduced in a series of the Recent form. The measurements of the jaw fragments and the premolar and molar teeth fall within the range of comparable lengths in the Recent form (Table 1).

TABLE 1

COMPARISON OF MEASUREMENTS OF 27 *UROCYON CINEREOARGENTEUS* MANDIBLES TO THOSE OF *U. SEMINOLENSIS.*

	Post. end of C alv. to post. end M_3 alv.
seminolensis	54.0 mm.
cinereoargenteus	47 mm. to 55 mm., mean 50.1 mm. (s.d. 1.95)
	Post. end M_3 alveolus to tip of angle
seminolensis	31.0 mm.
cinereoargenteus	27 mm. to 34 mm., mean 30.1 mm. (s.d. 1.58)

A distinct entoconid on M_3, and a ridge running from the apex of the hypoconid to the base of the protoconid were described as diagnostic, but are, like the other characters, present on numerous specimens of *U. cinereoargenteus.*

In addition to the speculative nature of *U. seminolensis,* the recent acquisition of a nearly complete skeleton including a near perfect skull (UF 2985) of *Urocyon* from Arredondo, Alachua Co., Florida, in a rich Pleistocene deposit clearly shows that the animal in question is *U. cinereoargenteus.* This excellently preserved specimen is clearly referable to the extant species.

Continued investigation of the Florida Pleistocene mammalian fauna indicates that few, if any, of the genera that have persisted into the present time are represented by different species. On the basis of this new material and reconsideration of the diagnostic characters of *seminolensis,* I feel that this extinct form is identical with *Urocyon cinereoargenteus* and has no nomenclatorial validity. Andrew A. Arata, University of Florida, Gainesville.

Quart. Journ. Fla. Acad. Sci., 22(2), 1959.

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Vol. 22 **September, 1959** **No. 3**

Contents

Emme—Two Exploratory Studies on Inter-Faith Dating 137

President's Report 146

Jackson—Soil Fungi from Chrysanthemum Plantings 147

Phillips—Notes on the Marine Flora of the Marquesas Keys, Florida 155

Almodovar and Blomquist—The Benthic Algae of Bahia Fosforescente, Puerto Rico 163

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TWO EXPLORATORY STUDIES ON INTER-FAITH DATING[1]

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These exploratory findings on inter-faith dating make clear that the questions and problems of young people still serve as strong motivation for their thinking and living. However, a survey of such interests in the experimental findings, and other valid literature in the related fields of "dating" and "mixed-religion marriages", reveals that little is known factually about our present field of inquiry, inter-faith dating.

The two exploratory studies reported here reveal many of the issues of inter-faith dating among 345 high school and 428 college students.

SETTING FOR THE STUDIES

For several years I had some responsibility for directing the discussion of high school students who wanted inter-faith questions answered while in attendance at an annual high school religious emphasis day. Interestingly enough H. C. Bradshaw (personal communication) reports that in the last eight annual polls in Peoria, Illinois, the topic of inter-faith dating has been the No. 1 topic of interest for high school students. For some time I have discussed this topic in courses on psychology of religion, marriage and dating, and adolescent psychology. Counseling youth and those in marriage situations further discloses this problem topic to be not only interesting but basic in marriage counseling diagnosis.

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[1] This report was presented at the 1958 meeting of the Florida Academy of Science.

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DELIMITATION OF THE STUDIES AND THE SAMPLING

Study I involved 345 high school students in a city of 110,000. The sample is well distributed according to class, age, and sex. Religion is largely Protestant as only a few Roman Catholics were included.

Study II comprised 428 college students in a southern college of 2500 students. The sampling was drawn from various liberal arts classes in the college, well distributed according to age, sex, college class, and most of them stated church membership. Geographically, 51 percent are from Florida and the remaining 49 percent from Northern and Northeastern states. Here too the sample is largely Protestant, as there were very few Jewish students and only 32 Roman Catholics included.

A check-list requesting information as suggested in the two samples was headed: "No name is to be given; so answer frankly and fully". These students were asked this specific query: Briefly indicate the most important inter-faith dating question or problem you have been thinking about and want solved.

A Few of the Questions Suggest the Focus of the Studies

1. College students asked:
    1) My aunt and uncle came from different churches, why shouldn't they get along?
    2) Why should my parents interfere with my inter-faith dating?
    3) As a Protestant, I am engaged to a Catholic girl. When we marry how do we get it fixed up at some church?
    4) Why is it that some of my friends are having difficulty when dating someone of a faith of the same name or denomination, but they seem to have different views?
2. High School students asked their questions:
    1) Should one ever date someone of a different faith?
    2) Why do so many teen-agers and their parents differ so much on inter-faith views?
    3) Should I spend much time worrying about my friend's different religion?
    4) I don't understand why college students should be so interested in such topics as birth control; and why is

this such a strong Protestant-Catholic inter-faith issue? Isn't this a health problem primarily?

Salient Findings

Table I gives the general summary of the questions asked by 345 high school and the 428 college students. These questions were organized into ten area-groups, and are listed in the order of the largest number of questions. The findings on these two studies and a brief discussion of them follows as they are listed in Table I.

TABLE I

FREQUENCY OF THE INTER-FAITH DATING QUESTIONS RAISED BY 345 HIGH SCHOOL STUDENTS AND COMPARED WITH 428 COLLEGE STUDENTS. (Emme)

Resulting Areas of Student Questions	(I) H. S. Students		(II) College Students	
	No.	%	No.	%
I. Mixed-Religion Marriages	87	25	185	43
II. Inter-Faith Dating	72	20	63	15
III. No Questions by few Students	53	15	49	11
IV. Mate Agreement. Engaged or have some understanding	6	2	51	12
V. Attitude toward Parents	31	9	16	4
VI. When Children are born	28	8	36	9
VII. Emotional, Personal Adjustment, and Sex Questions	19	6	—	—
VIII. Dating Standards and Ideals	17	5	—	—
IX. Religious Belief, Reforming Others, Liberal or Conservaative Attitudes, Tolerance, etc.	16	5	20	4
X. Inter-Racial Dating and Marriage	16	5	8	2
Total	345	100%	428	100%

Findings

Reactions to a partial presentation of these studies at the 1957 Florida Academy of Science and the 1957 (Purdue U.) sessions of the National Council on Family Relations, subsequent inquiries, and the response to the 1958 (U. of Oregon) session revealed that academic and professional leaders, curriculum and program builders, parents, clergy and lay workers were much interested in the anticipated findings to be presented in this report. In fairness to the facts derived from two exploratory studies, consensus judgment leads the writer to state these findings as tentative inferences.

1. These high school and college students were much more interested in mixed-religion marriages than they were in inter-faith dating (Area I). This area with the greatest number of questions, 272 (87 plus 185) revealed that 43 percent of the college students and 25 percent of the high school students presented their written question on mixed-religion marriages. The reason for this student "switch" from the inter-faith dating question under consideration is not fully known. Perhaps some had seen mixed-religion homes at close range. Others might have been giving thought to the direction their own inter-faith dating might be going. Some students revealed a certain smugness or indifference in their attitudes. "Dating and marriage are my business, I'll cross the marriage bridge when I come to it", said others. Most of them did not seem to understand the added burden, or dilemmas that a mixed-religion marriage adds to the general marriage situation. Emme (1958) presented eleven such added home burdens or pitfalls.

2. More high school (11 percent) than college students (6 percent) wanted to know specifically "just how successful are interfaith marriages?". Bossard and Boll's (1957) six mixed-marriage cases give information which motivated student interest in reading and subsequent discussion. Since this question has been raised in so many different discussion groups, two sources of reliable information make it clear that mixed-religion marriages increase the percentage of divorce and separation according to three major researches as summarized by Evelyn Duvall (1958), and the findings of J. Landis (1957).

3. Some form of compromise marriage was assumed to be easily arranged by both groups, but more especially, the college group (Area I). "Who is to give in?" asked a number. Others were sure that since you are in love "Everything will work out all right". Still others were more sophisticated and insisted that "some church deal can always be worked out".

4. Putting it mildly, these Protestant youths were much concerned over the rules of the Roman Catholic church (Area I). Some of the high school students were curt, unfair, and very critical of parochial and marriage procedures of Catholicism. A few college students, a little more tolerantly, inquired about Catholic-Protestant marriage possibilities.

5. Twenty-two college students sensed liberal and conservative views within the same Protestant denomination, as a hindrance to a happy marriage (Area I). High school students were more tactless and critical, while the college students seemed a little more tolerant. These differences appear later, much more sharply and concretely, in inference 17.

6. These young people give much evidence that they were interested in inter-faith dating questions only as a second choice question. A comparison of topics I and II reveals that the frequencies of the questions drop from a total of 272 questions on mixed-religion to 135 questions on dating. Perhaps a number of students found it easier to raise a question on a mixed-religion home of someone else rather than refer to aspects of one's own romantic and personal dating experience. Many of these youth supported this position by indicating that "adults should not interfere anyway".

7. More high school (13 percent) than college students (5 percent) were disturbed over dating those of other faiths (Area II). Three important questions were raised by the high school students with much feeling: "What's wrong with such dating?"; "Will only a few dates make a difference?"; "I just can't see anything wrong with inter-faith dating, do you?" These are earnest but highly emotionalized questions. Leaders and research specialists in the fields of mental hygiene, psychological counseling, and guidance should be interested in the nature of this emotional intensity shown by these high school youths.

8. Some high school students pointed out rather sharply in their questions that their religious beliefs and church practices affected their conduct on inter-faith dates (Area II). Places of entertainment, drinking, smoking, and other forms of amusement were mentioned and discussed at some length by a few. Others took an opposite position and presented questions similar to this one:

"Who wants to discuss or think religion while on an inter-faith date?" Here is a finding that deserves much more consideration than space permits here.

9. Most college students are determined to continue their inter-faith dating and accept the possibility of falling in love with someone of a different faith, or even with a non-believer. This finding runs like a golden thread throughout the study. Their lack of factual understanding and insight amounts to the same fallacy found in the field of general dating, "If two people are sincerely in love everything will work out satisfactorily". So this rather new inter-faith dating topic adds a new kind of fuel or evidence to an old "falling-in-love fallacy". In our 1955 discussion of this topic nine groups of high school students showed considerable awareness in this connection. The nine discussion leaders reported back to us that this persistent question kept coming up: "How can I know when I am beginning to fall in love with an inter-faith partner, so I can break off the inter-faith dating before this takes place?" Some openmindedness is revealed here and may serve to suggest that if leaders are to get anything constructive done on this topic, it must be before the college years.

10. A central idea pervades the inter-faith dating perspective of these young people. With a smug and complacent attitude they do not sense their limited understanding of the inside and intimate situations of mixed-religion homes. Few have a chance to sense the "void or emptiness" in some of the homes such as are described by the well known Catholic writer, J. A. O'Brien (1957) and the "feeling of being left out caused by a domineering religion". Or how is justice to be done to the questioning child in such a home who asks one parent about the other parent's religion; this second parent answering later, when each parent is trying to protect his mate and his mate's religion—all these factors causing a dilemma for the child. Such "inside home facts and dilemmas" are seldom known or considered by those outside the mixed-religion home. Emme (1957) has presented a list of such overlooked dilemmas.

11. There is a strong conviction in both groups that much can be gained from inter-faith dating. Learning to understand others, and their religious views in particular, should develop a tolerance of understanding, insight, and helpful community perspectives. No doubt, parents especially, have seen young people of different

faiths demonstrate a common interest in the community by promoting worthy humanitarian causes and issues without religious friction.

12. Students who did not present a single question were found in various groups and cause some concern. 24 college students (6 percent) who reported four or more dates weekly (heavy dating), presented no question. College Deans and Counselors would have some idea about hidden questions. 20 non-daters naturally had no questions. 30 of the high school group were not dating. "Heavy daters" and "non-daters" involve many considerations.

13. Some mate agreement was evident in both groups (Area IV). Since 108 high school seniors were involved there was much dating activity among them. 12 percent of the college students reported they were engaged or had an understanding in some form: verbal 30; diamond ring 8; fraternity pin 8; other jewelry 5. This study did not reveal the number going steady.

14. Inter-faith dating questions, involving reciprocal attitudes and responsibilities of students and their parents, were sharply directed (Area V). 9 percent of the high school students questioned the right of their parents to interfere with their inter-faith dating. Others continued dating, a number going steady, when parents opposed. This adolescent blast reveals that a number of high school students and their parents were very far apart friendship wise. Only 4 percent of the college students indicated parental difficulty. They were not so critical of their parents but some boldly indicated they continued this dating in spite of their parents. A few revealed some maturing by asking questions like this one: "How do you get your parents to understand you in your dating plans?"

15. These uninformed Protestant youths seem to have overlooked the fact that they lacked information on various church policies, beliefs, practices, and sacredness of vows taken (Area VI). These questions were usually varied and intolerant, but especially seemed to disregard the ethical significance of vows taken. The birth of children in a mixed-religion marriage was vitally associated with such topics as birth control, choice of a hospital, ceremony of baptism, and later selection of a school.

16. High school students expressed some concern over dating standards and conduct, while the college students were conspicu-

ously silent on such questions (Areas VII, VIII). Questions were asked about: heavy petting, side road parking, dating standards, and dating "finesse". Ehrmann's (1955) research with college students in the general dating area indicated how far some college students go in their intimate relationships and heavy petting. Could such data have a bearing upon the college silence in not presenting a question? It should be added that college students who dated four or more times weekly were classified as heavy daters. Such heavy dating combined with little openmindedness, I am naming as "Youth's Dating Inversion".

17. Some high school students imposed rather exacting religious demands upon their inter-faith dating partner, as a prerequisite to dating (Area IX). 5 percent of these students were much exercised as they dominated the discussion in some groups for a considerable time. Some insisted on a specified emotional experience; some required socalled "conversion". Note how sharp a few of these high school questions are:

1) "Should I insist on my boy friend becoming converted? He is now a sinner".

2) "What should I do as my friend is not saved and does not care to be?"

3) "What is liberal and conservative as far as churches are concerned?"

4) "Is it not dogmatic theology imposed on us that gives us our problems?"

These pointed high school questions deserve a tolerant but truthful answer. Some can be answered in young people's church groups, some inter-church groups, and others where the student chooses his own counselor. The college students with only 4 percent of their questions in this area were not so pointed but did refer to religious values, historical method of Bible study and church work. A much involved area of topics could be introduced here if churches with their leaders, and cooperating with other church leaders and specialists, attempt to improve the interfaith dating situation. A challenge confronts churchmen, parents, and other leaders. If many of the conservative and liberal adults cannot cooperate on religious interests and activities in the community, how can we expect these young people to settle adult views of churchmanship and elementary theology while they are in the center of the all consuming and romantic task of "falling in love"? No wonder these college students, with only a few added years of maturing over high school students, were less positive and more cautious, and so asked no sharp questions in this connection.

LITERATURE CITED

BOSSARD, JAMES H. S., and ELEANOR S. BELL

1957. One Marriage: Two Faiths. Ronald Press. Ch. 2.

DUVALL, EVELYN

1957. Family Development. J. B. Lippincott Co., Chicago. Ch. 6, P. 145.

DUVALL, EVELYN, and J. D. JOHNSON

1958. The Art of Dating. Association Press. Chs. 4, 8.

EHRMANN, W. S.

1955. The Influence of Comparative Social Class or Companions upon Premarital Hetero-sexual Behavior. Marriage and Family Living. February. Pp. 48-53.

EMME, EARLE E.

1958. Step I in Home Planning. Vital Speeches. January. Pp. 179-183.

1958. Inter-faith Marriage Difficulties (Pitfalls). Vital Speeches. January. P. 182.

1957. Inter-faith Aspects of College Dating. Quarterly Journal of the Florida Academy of Science. December. Pp. 243-252.

1950. Stenographic Record of a Public Panel on Inter-faith Dating and Marriage (unprinted). Bradley University. Pp. 1-24.

LANDIS, JUDSON T., and MARY G.

1958. Building a Successful Marriage. Prentice-Hall, Inc., New York. Third Edition. Pp. 71, 72.

O'BRIEN, JOHN A.

1957. A Happy Marriage. Popular Library. New York. P. 119.

REPORT TO THE MEMBERS OF THE FLORIDA ACADEMY OF SCIENCES

Since the last annual meeting of the Florida Academy at Jacksonville University in December of 1958 there have been a number of developments of interest.

The date of the annual meeting this year has been moved to February 18-20, 1960 to avoid conflict with the Caribbean Conference and to permit more time for the preparation of papers and projects by members of the Academy. Titles of papers should be submitted immediately to the Chairmen of the sections.

The Council has authorized the new Science Teaching Section. This section should constitute a forum where problems of science teaching at all levels may be discussed and where teachers at all levels will participate in the programs. A number of secondary school teachers have expressed considerable interest. It is not intended to segregate those whose primary interest is teaching from those whose primary interest is research but to permit an exchange of ideas among all who are interested in science. It should be noted that the Florida Association of Science Teachers will meet with us in Lakeland. We hope that many of these teachers will participate in our activities and will join the Academy. As authorized by the Council I have appointed a committee to determine the best means of honoring outstanding science teachers in Florida.

Two amendments to the By Laws have been submitted to the membership for consideration at the annual meeting in Lakeland. Each member is asked to come prepared to vote on these proposed changes, copies of which have been mailed.

Dr. Louella Dambaugh, our President-elect, has conducted an extremely active and successful membership campaign as a result of which many new members have joined the Academy.

The Council hopes to include news and notes of interest to Science and Scientists in each future number of the Journal. All of those who know of items which might be of interest are requested to send them in to the President.

The Florida Academy of Sciences was organized at a meeting held at the University of Florida in February, 1936. February, 1961 therefore represents our twenty-fifth anniversary. A committee has been appointed to make this 25th Anniversary meeting a outstanding scientific event in the State.

The February 1960 meeting should be one of our biggest and best. I hope to see most of you at Florida Southern, February 18-20.

E. Ruffin Jones
President

SOIL FUNGI FROM CHRYSANTHEMUM PLANTINGS[1]

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Gulf Coast Experiment Station, Bradenton

As a part of a study of soil-inhabiting plant pathogenic fungi, qualitative fungal analyses were made of soil samples collected at regular intervals during one year from commercial and experimental plantings of *Chrysanthemum morifolium* Ram. in Florida. The data presented primarily concern the identity rather than numbers of isolated fungi.

Previous surveys of the kinds of fungi in soils of the southeastern United States are limited to Louisiana and Georgia and were reviewed by Miller, *et al.* (1957). In Florida, studies have been directed toward estimating changes in numbers of soil microorganisms resulting from agricultural practices.

Three soil types were present in the 6 areas sampled. Two plantings were on St. Lucie fine sand, 3 were on Leon-Immokalee fine sand, and 1 was on Bradenton fine sand. These soils were, in every case, amended by the addition of peat and had been used for the culture of chrysanthemums during the previous year. The soil in each sampled area had been treated with steam, Vapam, or Mylone prior to planting to reduce the numbers of nematodes, fungi, and weeds. The pH values of the soils were between 5.6 and 6.8. The soil pH did not fluctuate more than 0.4 units in any area during the sampling period.

Materials and Methods

Samples from chrysanthemum beds were taken monthly, beginning prior to planting or within the first week after planting. Only 3 or 4 samples could be obtained during the crop period. Samples were collected in 2 series, the first during September-December from 2 commercial Yellow Iceberg plantings and 1 experimental mixed variety planting. The second series samples were collected during January-March from 3 commercial Iceberg plantings and 1 experimental mixed variety planting. All samples were collected monthly within a 10-day period.

Each soil sample, consisting of a pooled lot of 7 sub-sample cores, was taken from 1 bed in each area sampled. A soil sampling tube 1 inch in diameter was used to extract a cylindrical sample 6 inches long. The sub-sample cores were obtained from the same locations within the bed on successive sampling dates. Plastic bags, used to contain the samples, were disinfested before use and the sampling tube was immersed in 10% Clorox before each sample extraction.

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[1] Florida Agricultural Experiment Station Journal Series, No. 956.

In the laboratory each sample was mixed thoroughly and 12.5 g portions were placed in 3 separate flasks containing sterile 1% methyl cellulose solution. After roiling 15 seconds with an electrical mixer, one further dilution was made bringing each replicate dilution to approximately 1 in 5000. The moisture content of each sample was determined later and final soil dilutions were calculated. Sample data were adjusted to a dry-soil weight basis. Three Petri dishes, each containing 1 ml of the final soil dilution and approximately 10 ml of Rose Bengal-Streptomycin (RB-S) medium, were prepared from each sample replication. Aseptic techniques were used throughout laboratory processing. The cultures were placed at 24° C for 5 days after which they were marked to define the position of original colonies. Fungi were identified within 14 days.

The RB-S medium was similar to that used by Martin (1950) except that the Rose Bengal concentration was decreased to 1 in 67,000 and 60 μg of streptomycin sulfate per milliliter of medium were used. Czapek's medium was used for the identification of species of *Aspergillus* and *Penicillium*.

RESULTS

A soil dilution of 1 in 5,000-6,000 was satisfactory in most instances and permitted discrete growth of fungal colonies, especially those developing from samples collected soon after soil treatment. Mean estimated numbers of fungal bodies per gram of dry soil ranged from 12,000 (all initial samples) to 56,000 (all terminal samples). Fungal populations increased in all areas during the sampling periods but the rates of increase varied among sampled areas.

Identification of all fungi from the 49 samples was not possible since the routine nature of the study did not permit extensive subculturing. RB-S medium, while permitting the growth of a wide variety of fungi, was unfavorable for the sporulation of many fungi.

Eighty-five per cent of all fungi isolated were identified as to genus. Many isolations in various genera did not conform to the extant species descriptions available and were enumerated in a genus category. A tabulation of all identified fungi is given in table 1 with the percentage species frequency and the percentage genus frequency and abundance. Species frequency is the ratio of the number of samples in which the species occurred to the total number of samples. Genus frequency was calculated similarly. Genus abundance is the ratio of the total number of colonies of a genus in all samples to the total number of identified fungus colonies in all samples. Genus frequency and abundance are listed opposite the first entry of the genus.

A comparison of the genera of fungi from the 3 soil types revealed that only the genera *Penicillium, Fusarium, Trichoderma, Cladosporium,* and *Curvularia* were common to all soils during the spring sampling period. The numbers of genera in all soils were approximately equal but estimated fungal populations were consistently higher in samples from the planting on Bradenton fine sand. This soil has a greater moisture retention and is more compact than the other soils sampled. *Aspergillus, Mucor,* and *Rhizopus* were found in samples of Bradenton fine sand but were not found in other soils during the spring. The lighter sandy soils of the St. Lucie and Leon-Immokalee types had 8 genera in common. Three of these, *Phoma, Cephalosporium,* and *Phymatotrichum* were not found in samples of Bradenton fine sand.

Discussion

The most abundant genera in the samples were *Penicillium, Fusarium,* and *Trichoderma* which comprised more than half of the fungal colonies identified. These genera were also the most frequent. *Syncephalastrum, Aposphaeria,* and *Pullularia* ranked 4-6 in abundance but none of these genera had a frequency of more than 10 per cent since they were restricted in distribution to several related samples. *Cladosporium, Curvularia, Aspergillus, Mucor,* and *Cephalosporium,* ranking 4-8 in frequency, were not represented by many colonies in the samples in which they occurred. Of the 49 genera listed in table 1, 84 per cent belong to the Fungi Imperfecti while the remaining few are distributed among the 3 other classes. Only 66 per cent of the 61 genera listed by Miller *et al.* (1957) are classified in the Fungi Imperfecti and relatively larger numbers of Phycomycetes and Ascomycetes were found in their samples than in chrysanthemum soil samples.

The abundance ranking of genera from treated chrysanthemum soils is different from rankings given by workers in Georgia, Louisiana, and Texas. Surveys of soil fungi in these states revealed that *Aspergillus* ranked first or second in abundance. Miller *et al.* (1957) suggested that *Aspergillus* species are dominant in warm climates. A comparison between the order of abundance of fungi from treated Florida soils and from untreated cultivated or forest soils of other states is not entirely valid, since the presence or abundance of some fungi may be due to cultural practices. A soil treatment, by reducing the fungal population, favors the rapid growth of some surviving fungi. In addition fungal populations are influenced by the introduction of many genera of fungi on the roots and foliage of cuttings.

TABLE 1

SUMMARY OF FUNGI ISOLATED FROM SOILS OF CHRYSANTHEMUM PLANTINGS

	% Genus frequency	% Genus abundance*	% Species frequency
	Phycomycetes		
Blakeslea trispora Thax.	2	R	
Mucor spp.	16	1.1	
M. fragilis Bain.			2
M. racemosus Fres.			2
Rhizopus nigricans Ehrenb.	2	R	
Syncephalastrum racemosum (Cohn) Schroet.	6	10.0	
	Ascomycetes		
Arachniotus citrinus Massee & Salm.	6	0.3	
Chaetomium spp.	6	R	
Neocosmospora vasinfecta E. F. Smith	2	R	
	Basidiomycetes		
Rhizoctonia solani Kuhn	4	R	

TABLE 1—(Continued)

SUMMARY OF FUNGI ISOLATED FROM SOILS OF CHRYSANTHEMUM PLANTINGS

	% Genus frequency - abundance*		% Species frequency
Fungi Imperfecti			
Acremonium sp.	6	R	
Acrotheca sp.	2	R	
Alternaria tenuis Nees ex Fr.	14	0.4	
Aposphaeria sp.	8	5.3	
Aspergillus spp.	33	2.6	
A. *flavipes* (Bain. & Sart.) Thom & Church			4
A. *flavus* Link			8
A. *fumigatus* Fres.			2
A. *melleus* Yuk.			10
A. *niger* van Tiegh.			10
A. *ustus* (Bain.) Thom & Church			10
A. *versicolor* (Vuill) Tirab.			4
A. *wentii* Wehmer			2
Bispora sp.	12	1.0	
Botryosporium pulchrum Corda	2	R	
Botrytis cinerea Pers.	2	R	
Calcarisporium sp.	2	R	
Cephalosporium spp.	16	1.2	
C. *acremonium* Corda			4
Chalaropsis sp.	2	R	
Cladosporium spp.	43	3.4	
C. *herbarum* Link ex Fr.			33
C. *epiphyllum* Pers.			8
Coniothyrium sp.	2	R	
Curvularia spp.	35	1.0	
C. *geniculata* (Tracy & Earle) Boedj.			6
C. *lunata* (Wakk.) Boedj.			8
C. *pallescens* Boedj.			8
C. *tetramera* (McKinney) Boedj.			2
Diplodia sp.	2	R	
Fusarium spp.	45	13.1	
F. *lateritium* Nees ex Fr. emend. Sny. & Hans.			2
F. *moniliforme* Scheldon emend. Sny. & Hans.			4
F. *nivale* (Fr.) Ces. emend. Sny. & Hans.			2

TABLE 1—(Continued)

SUMMARY OF FUNGI ISOLATED FROM SOILS OF CHRYSANTHEMUM PLANTINGS

	% Genus frequency - abundance*		% Species frequency
F. solani (Mart.) Appel & Wr. emend. Sny. & Hans.			20
F. roseum Link emend. Sny. & Hans.			22
Gliocladium sp.	2	R	
Gliomastix sp.	4	R	
Gonatobotryum sp.	2	R	
Harpographium sp.	2	R	
Heterosporium sp.	2	R	
Humicola sp.	10	0.4	
H. brevis (Gilm. & Abb.) Gilm.			4
Masoniella grisea (Smith) Smith	4	R	
Melanconium sp.	10	0.3	
Nigrospora sp.	8	R	
N. sphaerica (Sacc.) Mason			6
Oospora sp.	2	R	
Paecilomyces varioti Bain.	4	0.4	
Penicillium spp.	84	35.3	
P. brefeldianum Dodge			4
P. charlesii Smith			2
P. citrinum Thom			10
P. decumbens Thom			14
P. herquei Bain. & Sart.			14
P. janthinellum Biourge			2
P. lanosum Westling			8
P. lilacinum Thom			2
P. oxalicum Currie & Thom			12
P. paxilli Bain.			8
P. simplicissimum (Oud.) Thom			4
P. velutinum van Beyma			2
P. wortmanni Klock.			14
Phoma sp.	22	2.0	
P. hibernica Grimes, O'Conner & Cummins			10
Phymatotrichum spp.	14	1.1	
Pullularia sp.	4	5.0	
P. pullulans (de Bary) Berkh.			2
Pyrenochaeta sp.	4	R	
Scopulariopsis spp.	4	R	
S. brevicaulis Bain.			2

TABLE 1—(Continued)

SUMMARY OF FUNGI ISOLATED FROM SOILS OF CHRYSANTHEMUM PLANTINGS

	% Genus frequency	- abundance*	% Species frequency
Sporotrichum sp.	4	0.3	
S. pruinosum Gilm. & Abb.			2
Spicaria sp.	4	0.4	
S. simplicissima Oud.			2
Stysanus medius Sacc.	2	R	
Stemphylium botryosum Wallr.	8	0.2	
Trichoderma spp.	53	12.7	
T. glaucum Abb.			4
T. viride Pers. ex Fr.			53
Trichothecium roseum Link	2	R	
Trichocladium sp.	2	R	
Zygosporium sp.	2	R	

* Genus abundance of less than 0.2% is listed as rare (R).

The relative paucity of *Aspergillus,* Phycomycetes, and Ascomycetes in treated soils may reflect differences in susceptibility of fungi to soil treatments as well as response to edaphic conditions.

Ascomycetes were absent from most samples. *Arachniotus citrinus* was isolated in several related samples in the early fall. The genera *Talaromyces* C. R. Benj. and *Carpenteles* Langer., listed by Gilman (1957) as the ascigerous stages of *Penicillium wortmanni* and *P. brefeldianum,* were isolated occasionally.

Fungi Imperfecti were the most numerous fungi in all samples. Several genera, apparently infrequently reported from soil, were isolated during the study. The genera *Melanconium, Aposphaeria, Diplodia, Gonatobotryum, Harpographium, Zygosporium, Calcarisporium, Bispora,* and *Acrotheca* are not included among the genera listed by Gilman (1957).

Isolations of *Trichoderma,* with the exception of *T. glaucum,* could not be separated on any basis other than occasional color and growth rate differences. This separation was not reliable since these differences occurred in a series of gradations. Therefore all isolates, except *T. glaucum,* were referred to *T. viride,* considered by Bisby (1939) to include *T. lignorum* Tode ex Harz and *T. koningi* Oud.

Rhizoctonia solani was isolated on only a few occasions; no other proven chrysanthemum pathogens were found. The relationships that may have existed among numbers and kinds of fungi and such variables as soil treatment methods, other cultural practices, varieties, and climatic conditions were not explored.

SUMMARY

Soil fungi were isolated from a total of 49 samples collected in 6 chrysanthemum plantings in Florida. The soils of all areas were treated before planting and sampling to reduce numbers of nematodes, fungi, and weeds. Forty-nine genera of fungi were identified, of which 41 were Fungi Imperfecti. The 3 most abundant and frequent genera were *Penicillium, Fusarium,* and *Trichoderma.* Approximately equal numbers of genera were isolated from 3 soil types sampled, but estimated fungal populations were greater in samples of Bradenton fine sand.

LITERATURE CITED

BISBY, G. R.
1939. Trichoderma viride Pers. ex Fries and notes on Hypocrea. Trans. Brit. Mycol. Soc., 23: 149-168.

GILMAN, J. C.
1957. A manual of soil fungi. Iowa State College Press, Ames, Iowa.

MARTIN, J. P.
1950. Use of acid, rose bengal, and streptomycin in the plate method for estimating soil fungi. Soil Sci. 69: 215-232.

MILLER, J. H., *et. al.*
1957. A survey of fungi of forest and cultivated soils of Georgia. Mycologia, 49: 779-808.

NOTES ON THE MARINE FLORA OF THE MARQUESAS KEYS, FLORIDA

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Florida State Board of Conservation Marine Laboratory [1]

The marine flora of the Florida Keys is luxurient and dense in many areas. Voss and Voss (1955) reported that *Thalassia* occurs in almost unbroken dense matted beds from the Biscayne Bay region to the Dry Tortugas. Taylor (1928), studying the Dry Tortugas algae, found that this assemblage was tropical in nature. Taylor (1929) reported a total of 478 different algae for the State, with 28 more names which were not sufficiently well known to justify inclusion at that time. Most of the algae reported were found at the Dry Tortugas.

The algal and seagrass floras of Key West and the Dry Tortugas have been studied by various workers and is the best known for marine plants in Florida. However, reports on the flora at the Marquesas Keys seem to be lacking. Millspaugh (1907) gave detailed information concerning the physical description of the Marquesas Keys and the terrestrial vegetation. No information was included on the submerged marine flora. Small (1913), reporting on the flora of the Florida Keys, did not include the Marquesas Keys. Bowman (1917) studied *Rhizophora* physiology at the Marquesas Keys, but did not mention seagrasses or algae. Davis (1940) listed three species of algae from the Marquesas in his work on the mangroves (see species list).

The Marquesas Keys are situated approximately 15½ nautical miles west of Key West and 45 miles east of the Dry Tortugas. Davis (1942) stated that the Marquesas Keys are composed of ten main islands and form an ellipse extending along a northeast-southwest axis. According to him the elliptic shape is the result of the strongest combined action of wind-formed currents, the Florida countercurrent which flows westward along the southern margin of the islands, and the tidal currents. A northeast current results which accounts for the elliptic shape.

Davis (1942) noted that: " . . . the outer faces of the islands around the Marquesas atoll receive the strongest currents and wave action, which cause the coarsest materials to pile up on these outer faces. Finer materials are deposited on the lee or inner faces of the islands . . . consequently the inner faces of the islands are mud flats covered by mangrove swamps".

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[1] Contribution No. 35 from The Fla. State Board of Cons. Marine Lab. Maritime Base, Bayboro Hrbr., St. Petersburg, Fla.

This paper provides a starting point for the knowledge of the marine flora of the Marquesas Keys.

The author is indebted to Drs. R. F. Hutton and V. G. Springer, and Messrs. K. D. Woodburn and H. C. Morgan, Jr., for their aid in collecting and for their helpful observations in the field.

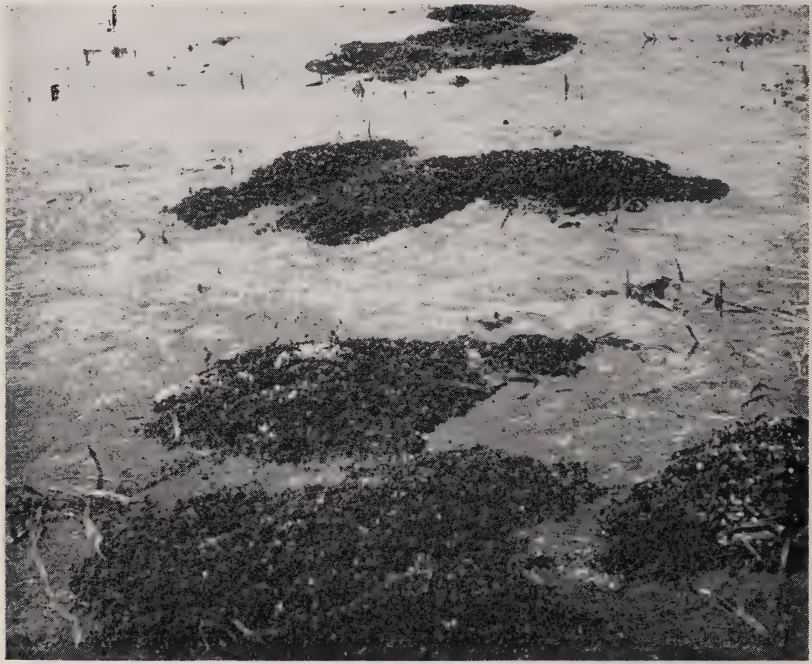

Fig. 1. Clumps of *Halimeda opuntia triloba* as found projecting out of water at spring slack low tide at the Marquesas Keys.

Discussion

This trip to the Marquesas Keys was made on 18 July 1959 during a period of full moon and spring tides. The water in all locations except station 6 was clear and transparent. Bottom details were clearly seen from the surface to the greatest depth at which observations were made, approximately 14 feet.

Station 1 was on the north side of Long Beach Key about one-half mile offshore. The depth varied from 3 to 5 feet on ebb tide. Very dense *Thalassia testudinum* was observed with leaves up to 1 foot long. *Syringodium filiforme* was seen in very sparse quantity interspersed in the *Thalassia*. Unattached *Dictyota divaricata* was present in abundance.

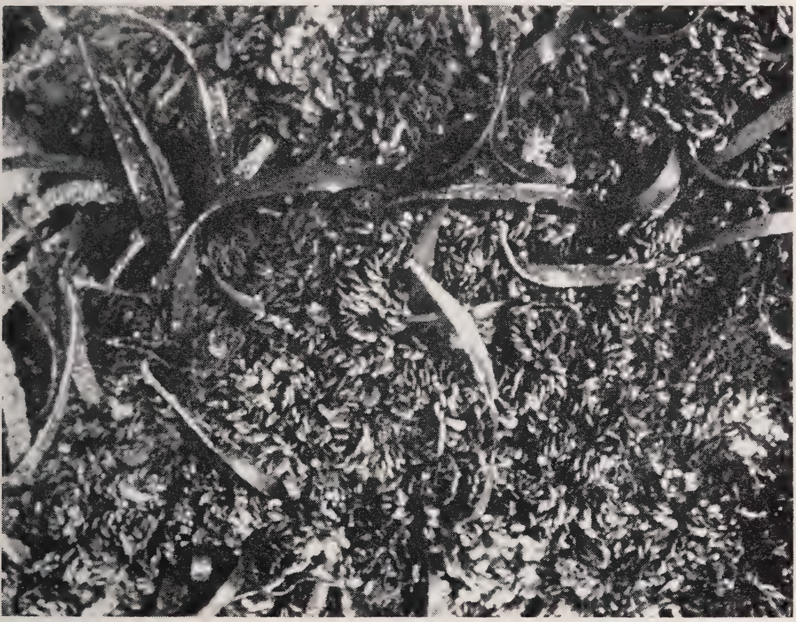

Fig. 2. Closeup of *Halimeda* clump to display density of growth. *Thalassia* leaves interspersed in the *Halimeda* growth.

The most detailed observations were made approximately one-half mile off the northwest tip of Long Beach Key, at station 2. The depth was 2 to 2½ feet on the ebb tide but fell to a depth of 6 inches on the slack low tide. The *Thalassia* growth in this area was so dense that a pushnet could not be operated effectively. *Diplanthera wrightii* was seen in very sparse quantity interspersed in the *Thalassia*. Woodburn (personal communication) reported that patches of *Diplanthera* were growing close to the shore of this key. Two species of *Penicillus* were conspicuous in this location. *Halimeda opuntia triloba* was extremely abundant in very large clumps. Many of these clumps were up to two feet long and nine inches high, projecting out of water at the slack low spring tide (Figs. 1 and 2).

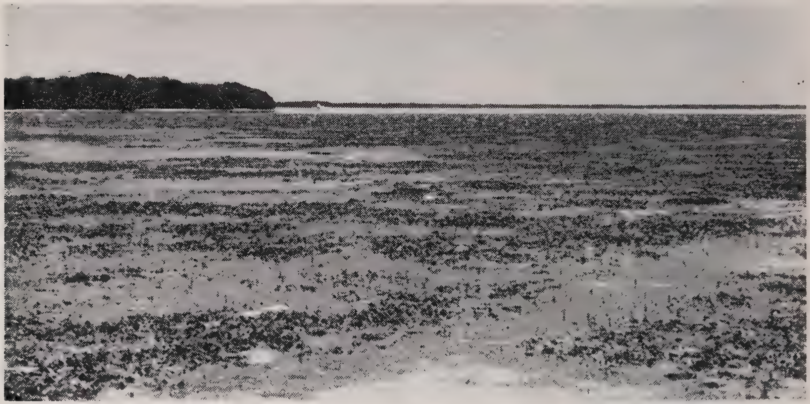

Fig. 3. Exposed flats at spring slack low tide. Taken ½ mile offshore at northwestern tip of Long Beach Key.

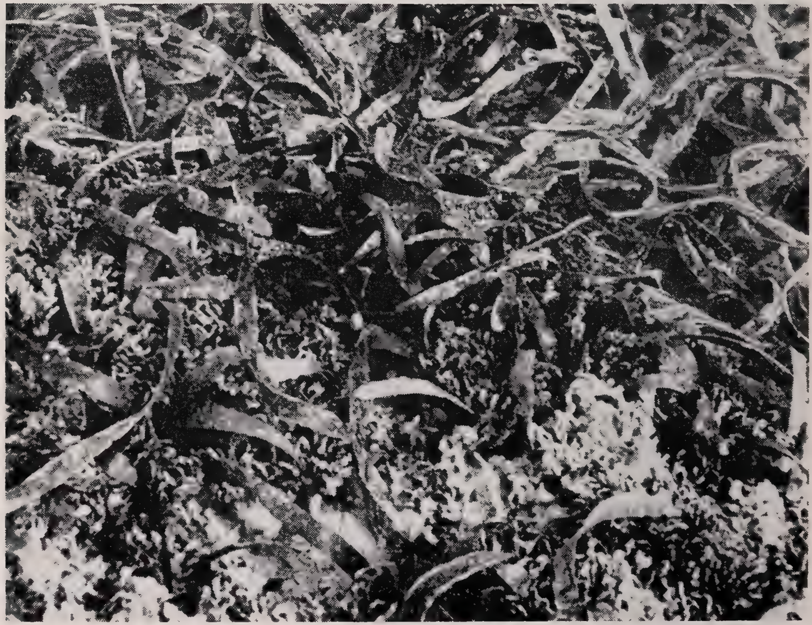

Fig. 4. Closeup of *Thalassia* leaves exposed to the air at slack low tide. *Halimeda* plants beneath leaves.

Close to shore, the bottom was exposed to air at slack low tide. Looking southeast from the area of station 2 vast exposed flats were seen (Fig. 3). At the station 6 inches of water was present, but *Thalassia* leaves were observed projecting out of water (Fig. 4).

The substrate at station 2 was composed of *Halimeda* segments (Fig. 5). A sparse amount of silt was present which emitted an odor suggestive of H_2S. An abundance of *Astrea* shells were interspersed among the segments. The living *Halimeda* was the obvious source of this bottom material. Probably, as the portions of the *Halimeda* left exposed at the spring slack low tides were killed, they were subsequently dislodged to the surrounding bottom. Wave action causing breakage of plants and natural death of segments are additional means of *Halimeda* accumulation on the bottom. This bottom was extremely coarse and loosely packed which made walking difficult. The author dug to a depth of 6 inches, 2 inches below the level of the *Thalassia* rhizomes, and encountered coarse *Halimeda* segments throughout. The depth to which these segments extended was not determined. The extremely dense

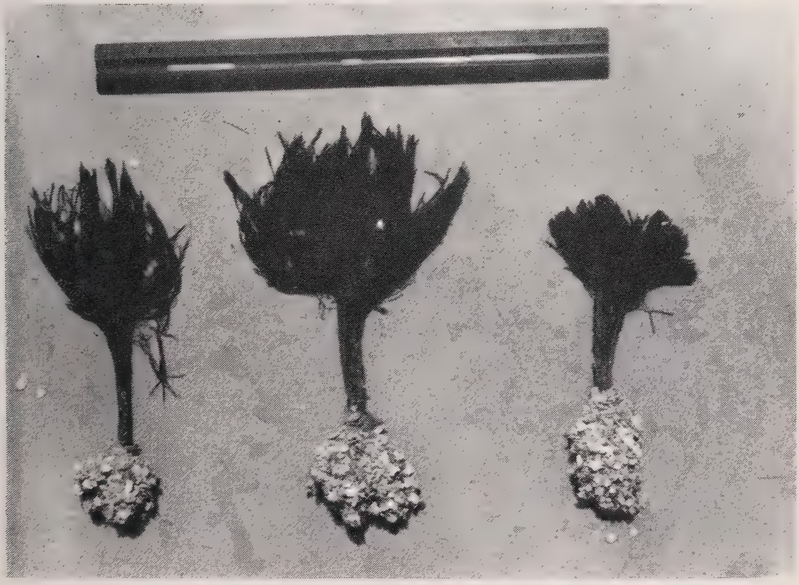

Fig. 5. Plants of *Penicillus dumetosus*. Notice is drawn to *Halimeda* segments bound by the rhizoid system. Taken to display character of bottom substrate.

growth of *Thalassia* on this type of bottom is interesting, and presents a striking contrast to the bottom types on which *Thalassia* has been observed by the author and others.

At station 3 the depth varied from 3 to 7 feet at slack low tide at a distance about 200 yards offshore. The bottom type was *Halimeda* segments and *Astrea* shells. Dense *Thalassia* growth was observed with occasional interspersed bare spots containing sparse amounts of *Penicillus dumetosus.* *Diplanthera* was observed in patches at the southwest tip of the keys.

The depth and bottom type for stations 4 and 5 were similar to that of station 3 except that very occasional exposed rock was seen in the area of station 4. *Thalassia* growth was dense. At station 4 the *Diplanthera* was more commonly seen than at station 3, and at station 5 it was not seen at all, but a few *Syringodium* patches were observed in 4 to 5 feet of water.

Station 6 was made in a channel on the inside of the keys. (See Fig. 6). This is one of the channels previously described by Davis (1942). The water was murky, with visibility limited to approximately 6 to 7 feet, while the depth of the channel was from 6 to 14 feet. *Thalassia* was observed growing in the channel to at least a depth of 6 feet.

All the *Diplanthera* collected or seen had leaves only 8 to 10 inches long but were wide bladed, up to 2.5 mm. This is as wide as the author has ever seen *Diplanthera* leaves.

From observations it appeared that most of the bottom around the outside of the Marquesas Keys was composed of *Halimeda* segments. *Halimeda* grew in large clumps around the keys, both inside on mud flats and offshore, at least to the 3 to 7 foot depth at spring slack low tide. At the shore line of the keys the bottom was composed of finely ground *Halimeda* segments.

Shallow mud flats were found to be extensive on the inside of the Marquesas Keys. *Thalassia,* whose leaves were left exposed at the spring low tide, was extremely dense on these mud flats.

Thalassia was observed in depths of 12-14 feet where it became very sparse. The most abundant growths were found from the shallowest flats to water 7 feet deep at the spring slack low tide.

A great amount of leaf kill was observed on the *Thalassia* leaves in the area. This is probably related to the exposure on the spring slack low tides.

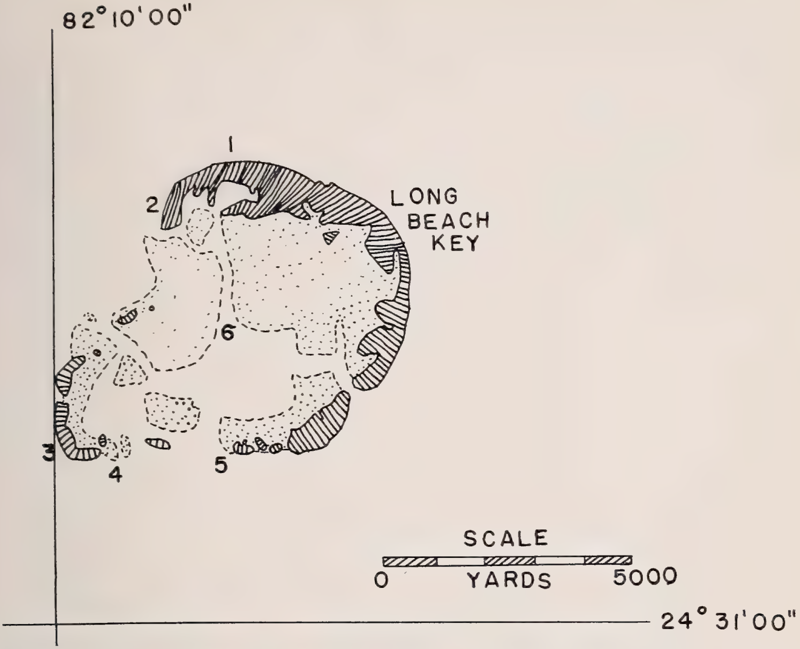

Fig. 6. Map of area with stations plotted. Shaded areas on inside of keys are shallow mud flats exposed at spring low tides.

A species list of the plants identified follows:

Seagrasses

Diplanthera wrightii Aschers.
Syringodium filiforme Kutz.
Thalassia testudinum Konig.

Algae—an asterisk designates an epiphytic plant.

Acetabularia crenulatum Lamx. (also reported by Davis, 1940).
Caulerpa cupressoides (West) C. Ag. (reported by Davis, 1940).
**C. cupressoides* (West) C. Ag. var. *typica* Weber.
**C. sertularioides* (Gmel.) Howe var. *brevipes* (J. Ag.) Sved.
Chaetomorpha gracilis Kutz.
**Cladophora delicatula* Mont.
Halimeda opuntia (L.) Lamx. var. *triloba* (Decaisne) Barton
Penicillus capitatus Lamarck
P. dumetosus (Lamx.) Blainville
**Phaeophila dendroides* (Crouan) Batters

Udotea flabellum (E. & S.) Howe
Dictyota divaricata Lamx.
**Centroceras clavulatum* (C. Ag.) Mont.
**Ceramium subtile* J. Ag.
**Chondria* sp.
**Fosliella farinosa* (Lamx.) Howe
Gracilaria cornea J. Ag. (reported by Davis, 1940).
Hypnea spinella (C. Ag.) Kutz.
Laurencia obtusa (Huds.) Lamx.
**Dichothrix fucicola* B. & F.
**Oscillatoria margaritifera* Kutz.
**O. nigro-viridis* Thwait.
**Plectonema nostocorum* Born.

LITERATURE CITED

BOWMAN, H. H. M.

1917. The ecology and physiology of the red mangrove. Proc. Amer. Philos. Soc., 56: 589-672.

DAVIS, J. H., JR.

1940. The ecology and geologic role of mangroves in Florida. Carnegie Inst. Wash. Pub. 517, Pap. Tortugas Lab., 32: 303-412, 12 pls., 7 figs.

1942. The ecology of the vegetation and topography of the Sand Keys of Florida. Carnegie Inst. Wash. Pub. 524, Pap. Tortugas Lab., 33: 113-195, 13 figs., 7 pls.

MILLSPAUGH, C. F.

1907. Flora of the Sand Keys of Florida. Field Columbian Mus. Pub. 118, Bot. Ser. 2(5): 189-245.

SMALL, J. K.

1913. Flora of the Florida Keys, being descriptions of the seed plants growing naturally on the islands of the Florida reef from Virginia Key to Dry Tortugas. xii & 162 pp. New York.

TAYLOR, W. R.

1928. The marine algae of Florida, with special reference to the Dry Tortugas. Carnegie Inst. Wash. Pub. 379, Pap. Tortugas Lab., 25: i-v & 1-219, 3 figs., 37 pls.

1929. Notes on the marine algae of Florida. Bull. Torrey Bot. Club 56: 199-210, 2 figs.

VOSS, G. L., and N. A. VOSS

1955. An ecological survey of Soldier Key, Biscayne Bay, Florida. Bull. Mar. Sci. Gulf & Carib., 5(3): 203-229.

Quart. Journ. Fla. Acad. Sci., 22(3), 1959.

THE BENTHIC ALGAE OF BAHIA FOSFORESCENTE, PUERTO RICO

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University of Puerto Rico and Duke Univesity

A small, shallow embayment on the southwestern coast of Puerto Rico, near the village of La Parguera, has become widely known for its spectacular luminescence throughout the year, which is responsible for its name Bahia Fosforescente. The uniqueness of this bay is that surrounding waters do not exhibit this remarkably regular luminescence. This has given rise to an interest in a relatively small area of about 45 acres regarding its animal and plant life and the environment in which they live, in comparison with the surrounding areas which do not show this striking luminescence.

The Institute of Marine Biology of the University of Puerto Rico was established in 1954. A field laboratory is maintained on the nearby island of Magueyes and several investigations have been undertaken on the systematics of the flora and fauna, as well as their ecology in Bahia Fosforescente, with the aim of finding an explanation for the striking luminescence of this area. Some of the investigations are still in progress and have, therefore, not been published, but those that have been published show some interesting facts.

Luminescence is first cited for this area by Harvey (1952) in his monumental work "Bioluminescence." In reporting on phytoplankton in waters in the vicinity of La Parguera, Margalef (1957) found an unusual concentration of dinoflagellates in this bay and concluded that the principal organism responsible for the luminescence is *Pyrodinium bahamense* Plate. In 1958, Burkholder and Burkholder reported on their investigation of the amount of B vitamins present in relation to productivity since certain species of dinoflagellates are known to depend on exogenous sources of B vitamins. They found that this area is richer in sediment and suspended solids than the surrounding areas, and by assaying the suspended solids found them quite high in vitamin B_{12}.

Since, so far, little is known about the taxonomy, local distribution, and ecology of the benthic algae of Bahia Fosforescente, it seemed worth while to make a survey of these algae with the hope that the results might be of some value in future investigations. This survey was done during February 1958, and December-January 1958-1959.

The shallow water of this bay is surrounded by thickets of mangroves, *Rhizophora mangle* L., *Avicennia nitida* Jacq., and *Laguncularia racemosa* Gaertn. f., except on each side of the narrow channel which connects it with the Caribbean Sea. Here the shoreline consists of rocks and pieces of dead corals. Although the bay is to some extent a typical lagoon habitat, it varies enough so it may be divided into three fairly distinct zones.

Zone A. This makes up the shorelines of the narrow connection of the bay with the outside waters, and, as stated above, is composed of such consolidated material as rocks and dead corals. The western shore is completely barren of mangrove vegetation, but the eastern shore shows an invasion of *Rhizophora* in scattered places. Owing to the prevailing east-southeast trade winds, the southwestern shore is exposed to strong wave action. A hill protects the southeastern shore from the predominant winds and is, therefore, relatively calm. On these substrata, the following species grow attached: *Laurencia obtusa, Laurencia papillosa, Valonia ventricosa, Sargassum polyceratium, Ectocarpus breviarticulatus, Dictyota divaricata, Amphiroa fragilissima, Caulerpa racemosa* var. *uvifera,* and *Wrangelia argus.* Also along these shores, many of the rocks are covered with a felt-like mass of *Calothrix crustacea* where exposed at low tide.

Zone B. In the broad expanse between the mangroves and the rocky entrance to the bay, the bottom consists mostly of a layer of soft, black mud. Various intergrading situations occur between this muddy bottom and white sandy areas, composed mostly of fragments of *Halimeda Opuntia.* On these bottoms it is common to find more or less extensive beds of the marine angiosperms *Thalassia testudinum* Koenig and Sims and *Halophila Baillonis* Aschers. Information regarding the composition of the bay's bottom sediments is given by Burkholder and Burkholder (1958).

Dredging in this zone was profitable only down to a depth of 8 ft.; in deeper water the bottom is completely barren of algae. Between the depths of 3-8 ft., in muddy sand not far from shore, profuse growths of the following occur: *Halimeda monile, Caulerpa cupressoides, Avrainvillea longicaulis, Dictyota Bartayresii, Penicillus capitatus,* and *Udotea flabellum.*

Zone C. This zone is composed of dense growth of *Rhizophora, Avicennia,* and *Laguncularia,* which provides a distinctive habitat along the western, northern, and eastern shores. A distinct group of epiphytic algal forms grow on the more or less submerged roots and stems of these plants. In a line transect from the outermost roots to those closer to shore, the algal vegetation diminishes markedly and is completely absent on the roots near the shore. Børgesen (1911), who observed this in his study of lagoons in the Virgin Islands, suggested that this is probably due to the increasing density of shade and the stagnant water near shore. The most common algae on or associated with mangrove roots are: *Caulerpa verticillata, Caloglossa Leprieurii, Centroceras clavulatum, Acanthophora spicifera, Murrayella periclados, Falkenbergia Hillebrandii,* and *Bryopsis pennata.*

A total of 50 entities have been collected in this area, which are distributed among the major groups of algae as follows:

	Chlorophyta	Phaeophyta	Rhodophyta	Cyanophyta	Total
Genera	12	5	18	4	39
Species	20	6	19	5	50

List of Species

Names with an asterisk indicate that this is the first published record, so far as known, from Puerto Rico.

Chlorophyta

Ulvaceae

Ulva Lactuca L. var. *rigida* (C. Ag.) Le Jolis

Cladophoraceae

Rhizoclonium riparium (Roth) Harvey

Dasycladaceae

Neomeris annulata Dickie

Bryopsidaceae

Bryopsis pennata Lamour.

Codiaceae

**Avrainvillea longicaulis* (Kutz.) Murr. & Boodle
Halimeda Opuntia (L.) Lamour.
Halimeda monile (Ell. & Sol.) Lamour.
Halimeda tridens (Ell. & Sol.) Lamour.
Penicillus capitatus Lam.
Udotea flabellum (Ell. & Sol.) M. A. Howe
Udotea conglutinata (Ell. & Sol.) Lamour.

Valoniaceae

**Valonia ventricosa* J. Ag.
Cladophoropsis membranacea (C. Ag.) Børg.

Caulerpaceae

Caulerpa verticillata J. Ag.
Caulerpa crassifolia (C. Ag.) J. Ag. f. *mexicana* (Sond.) J. Ag.
Caulerpa taxifolia (Vahl) C. Ag.
**Caulerpa cupressoides* (Vahl) C. Ag. f. *typica* Weber-van Bosse
**Caulerpa sertularioides* (Gmel.) M. A. Howe f. *brevipes* (J. Ag.) Svedel.
Caulerpa racemosa (Forsk.) J. Ag. var. *uvifera* (Turn.) Weber-van Bosse

PHAEOPHYTA

Ectocarpaceae

**Ectocarpus breviarticulatus* J. Ag.

Dictyotaceae

**Dictyota Bartayresii* Lamour.
Dictyota divaricata Lamour.
Dictyopteris delicatula Lamour.
**Padina gymnospora* (Kutz.) Vickers

Sargassaceae

**Sargassum polyceratium* Mont. (*S. vulgare* C. Ag. sensu Børg.)

RHODOPHYTA

Chaetangiaceae

**Galaxaura lapidescens* (Ell. & Sol.) Lamour.

Squamariaceae

Peyssonnelia rubra (Grev.) J. Ag.

Corallinaceae

Epilithon membranaceum (Lamour.) Heydr.
**Melobesia LeJolisii* Rosanoff
Amphiroa fragilissima (L.) Lamour.
Amphiroa tribulus (Ell. & Sol.) Lamour.
Jania capillacea Harvey

Hypnaceae

Hypnea musciformis (Wulf.) Lamour.

Ceramiaceae

Centroceras clavulatum (C. Ag.) Mont.
Spyridia filamentosa (Wulf.) Harvey

Gelidiaceae

**Wrangelia argus* Mont.

Delesseriaceae

Caloglossa Leprieurii (Mont.) J. Ag.

Rhodomelaceae

**Herposiphonia secunda* (C. Ag.) Ambronn
**Murrayella periclados* (Ag.) Schmitz
**Bostrychia tenella* (Vahl) J. Ag.
Laurencia obtusa (Huds.) Lamour.
Laurencia papillosa (Forsk.) Grev.
Acanthophora spicifera (Vahl) Børg.
**Falkenbergia Hillebrandii* (Born.) Falkenb.

CYANOPHYTA

Rivulariaceae

Calothrix crustacea Thuret

Oscillatoriaceae

Lyngbya majuscula Harvey
Phormidium penicellatum Gom.
**Oscillatoria Bonnemaisonii* Crouan
**Oscillatoria Corallinae* (Kutz.) Gom.

It is a pleasure to express our appreciation to Dr. Juan A. Rivero, Director of the Institute of Marine Biology, for his generous support of this investigation. Especial thanks are due Mr.

Jorge Rivera who kindly arranged for transportation and provided other facilities for collecting, and Dr. Francis Drouet of the University of Arizona for his determination of the last three species of Cyanophyta.

LITERATURE CITED

BØRGESEN, F.

1911. The algal vegetation of the lagoons in the West Indies. Saertryk Af Biologiske Arbejder Tilegnede Eug. Warming, 3 Nov. 1911.

BURKHOLDER, PAUL R., and L. M. BURKHOLDER

1958. Studies on B vitamins in relation to productivity of the Bahia Fosforescente, Puerto Rico. Bull. Mar. Sci. Gulf & Caribbean 8(3): 201-223.

HARVEY, E. N.

1952. Bioluminescence. Academic Press Inc. 649 pp.

MARGALEF, RAMON

1957. Fitoplancton de las costas de Puerto Rico. Inv. Pesquera 6: 39-52.

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Contents

Rosen and Kallman—Development and Evolution of Skeletal Deletions in a Family of Viviparous Fishes (Cyprinodontiformes, Poeciliidae) 169
Hammett—Sir Thomas Browne (1605-1682), Debunker of Popular Superstitions 191
Morgan and Gilcreas—Radioactive Monitoring and Environmental Health 197
Rossman—Herpetofaunal Survey of the Pine Hills Area of Southern Illinois 207
Akin and H. J. Humm—*Macrocallista nimbosa* at Alligator Harbor 226
Florida Academy of Sciences—Council—Editor—Sectional and Committee Chairman 229
Membership, Florida Academy of Sciences, March 29, 1960 230

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THE QUARTERLY JOURNAL OF THE
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DEVELOPMENT AND EVOLUTION OF SKELETAL DELETIONS IN A FAMILY OF VIVIPAROUS FISHES

(CYPRINODONTIFORMES, POECILIIDAE)

Donn Eric Rosen[1]
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and
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New York Zoological Society

Introduction

The cyprinodont fishes of the family Poeciliidae are from the New World and typically bear living young. Internal fertilization is made possible in these fishes by the development in the male of a modified and elongate anal fin (external genitalium or gonopodium) that is supported internally by a complex series of appendicular and axial bones (Figs. 1 and 2). The internal elements (gonactinosts), articulating directly with the pivotal bones of the fin rays carry the muscles that activate the fin. The gonactinosts are anchored firmly to the sexually modified hemal spines (gonapophyses) that project downward from the vertebral axis. In the course of revisional work on the family (Rosen, Ms.)[3], many apparently closely related genera and species were found to differ in the presence or absence of one or all of the normal complement of gonapophyses in their gonopodial suspensoria. The adaptive

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[1] Florida State Museum and The Department of Biology.

[2] Genetics Laboratory of The N. Y. Zoological Society, New York.

[3] Zoogeography and evolution of new world cyprinodont fishes of the family Poeciliidae, with a revision of the genera and materials for a revision of the species.

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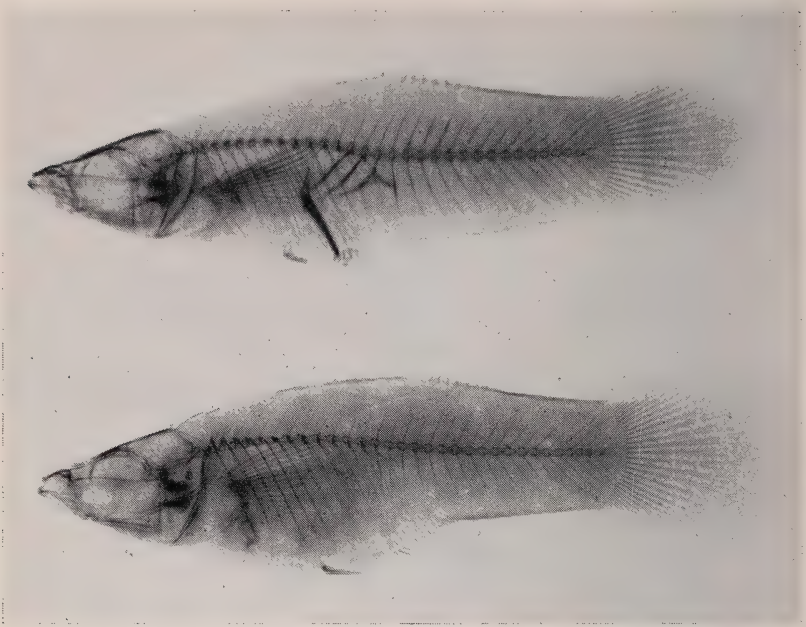


Fig. 1 Radiograph of adult male (above) and female (below) of the Cuban poeciliid *Gambusia punctata.* Note specialized, heavily ossified anal fin suspension (gonopodial suspensorium) of male, consisting of both axial and appendicular components.

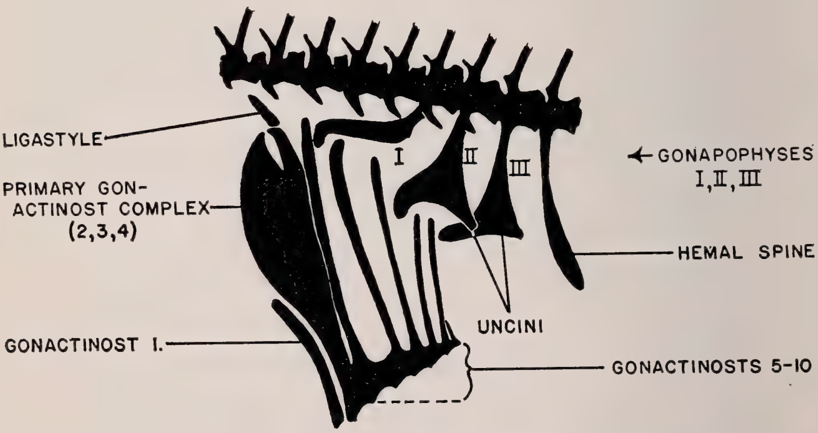


Fig. 2. Diagram of basic features of the gonopodial suspensorium of the Middle-American poeciliid *Phallichthys amates.* From Rosen and Bailey (1959).

significance of the loss or reduction of gonapophyses was not clear, but it was noted that the anal fin of species lacking these structures is inserted farther anteriorly than in species with them. Because those species lacking gonapophyses have their anal fins displaced unusually far forward in relation to the anterior hemal spines (Fig. 3) it was suggested that the developing appendicular elements in some way determine the presence or absence of, and growth and form of, neighboring axial structures (Rosen, 1959).

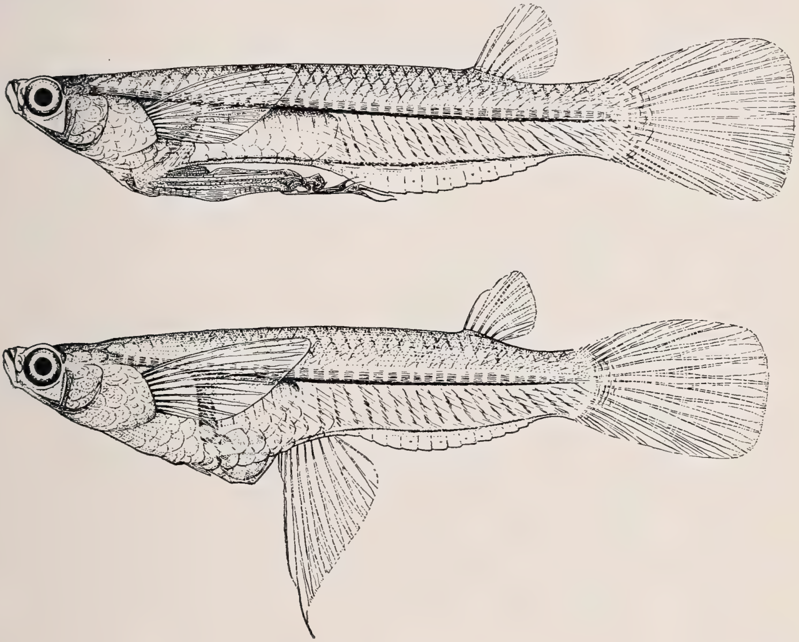


Fig. 3. Adult male (above) and female (below) of the South American poeciliid *Tomeurus gracilis*. Note 1) modification of the male's anal fin as a complex, rod-like external genitalium (gonopodium), and 2) the anterior displacement of the male's gonopodium compared with the position of the female's unspecialized anal fin. This is an example of a species in which the accentuated anterior displacement of the gonopodium is correlated with the absence of gonapophyses in the gonopodial suspensorium of the male. See also Figure 9.

In normal development the anal fin suspensorium passes through a period of histolysis that results in the gradual dissolution of the anterior hemal spines (Fig. 4). In the developing female, histolysis

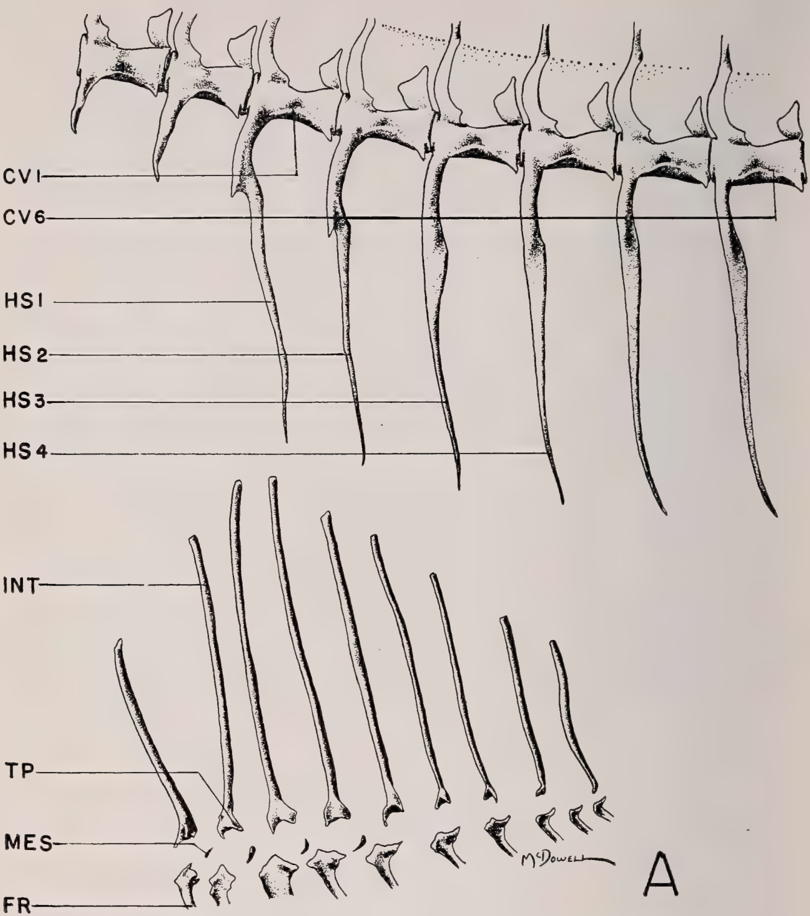
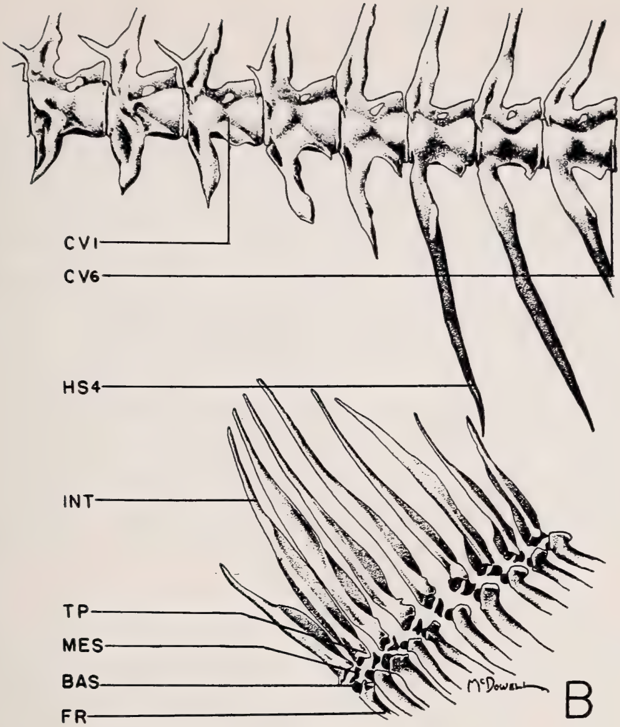


Fig. 4. Stages in the development of the anal fin suspensoria of male and female of the Middle-American poeciliid *Xiphophorus maculatus*. A. Juvenile. B. Female. C. Developing male. A, B, and C not to scale. *aap,* anterior articular process; *bas,* baseost; *cv,* caudal vetebra; *fr,* fin ray; *gon,* modified hemal spine or gonapophysis; *gonac,* modified actinosts or gonactinost; *hs* hemal spine; *int,* interhemal spine or actinost; *lig,* ligastyle; *lp,* lateral process; *mes,* mesonost; *pap,* posterior articular process; *tp,* transverse process. Note in B the loss of three hemal spines, in C the partially histolyzed first hemal spine, the upper margin of which has moved forward a distance of one vertebra, and also in C the addition of new bone to and consolidation of axial and appendicular elements.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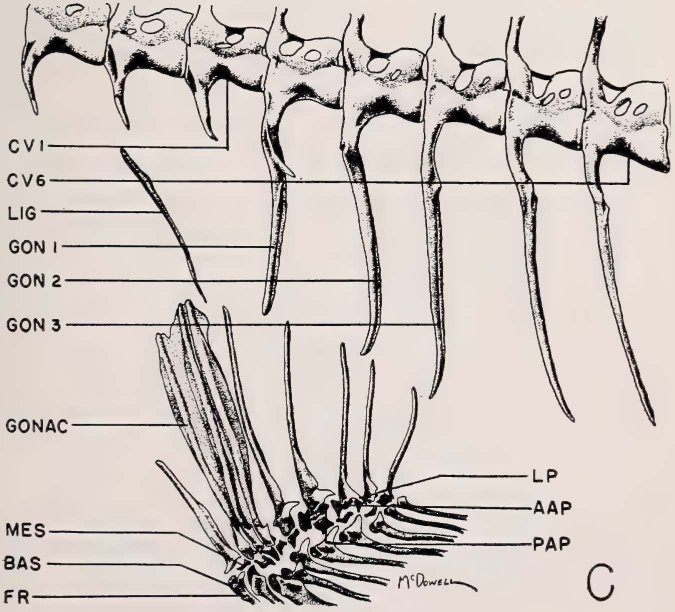
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proceeds unchecked and as many as four of the anterior hemal spines may be eliminated. In the maturing male the histolytic changes are counteracted by the rapid addition of bone and typically no more than a single hemal is eliminated before osteogenesis sets in. Hence, if the underlying appendicular elements provide an inductive stimulus for bone growth in the axial region, their removal at an early stage in development should permit the histolytic process to go to completion and produce a male fish without modified hemal spines (gonapophyses). A variety of experiments were designed to test this hypothesis. Specifically information was sought on the following points: 1) the presence of an induction arising from appendicular tissues, and 2) the competence of skeletal elements other than those in the vicinity of the anterior hemal spines to respond to an induction by the same transplanted appendicular tissues. An evolutionary interpretation of the results is proposed.

Materials and Methods

> Four species of poeciliid fishes were used in these experiments: *Xiphophorus maculatus,* with three suspensorial gonapophyses, *Lebistes reticulatus,* with two gonapophyses, *Limia vittata,* with two gonapophyses, and *Phalloceros caudimaculatus,* with three gonapophyses (this species is closely related to *Cnesterodon decemmaculatus,* which has none).

Technique for removal and/or transplantation, or in situ *reversal of anal fin.* The fish is placed upside down in a shallow dish and supported on either side by a wad of wet cotton. After removal of the scales around the fin a vertical incision is made with a sharp glass needle immediately in front of the first anal fin ray in order to separate it from the large retractor ischii muscle. The needle is then slowly moved backward on either side of the fin to extend the incision to the level of the last fin ray. With a pair of forceps the fin rays and their gonactinosts are grasped and the fin is gently pulled out. Occasionally the fin will tear before the last fin rays have been lifted off, leaving them or only their gonactinosts behind.

The method for transplanting anal fins was described previously by Kallman and Gordon (1957, 1958). This involves the insertion of the gonactinosts of the extirpated fin into a slit-like pocket that has been prepared in the musculature of the host. The gonactinosts of the fin graft are trimmed in order to keep the pocket as small as possible. The entire series of operations, i.e., removal of the fin and its implantation at an ectopic site takes less than three minutes. During the operation no anesthetic is used. After the operation the fish are kept for three days in a 0.6% sea salts solution to inhibit bacterial or fungus infections. Post-operative mortality is below ten per cent. Approximately seventy per cent of the operated fish eventually differentiated into females, leaving comparatively few males in any one experimental series. Experiments were performed on a total of 140 immature fish, of which 24 were *Phalloceros caudimaculatus,* 80 *Xiphophorus maculatus,* 28 *Lebistes reticulatus,* and 8 *Limia vittata.*

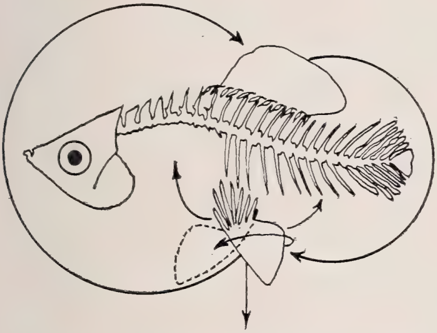

Fig. 5. Diagram summarizing experiments involving removal of the anal fin (straight arrow), *in situ* anal fin reversal (dashed lines), ectopic anal fin transplants, and transplantation of the dorsal fin into the anal position (the latter experiment still in progress and not reported here). No more than two of these experiments were performed on a single fish . See Materials and Methods.

When no inbred strains are available, the excised fin must be transplanted into the same individual in order to survive (autograft), whereas in *X. maculatus* the fin may be successfully transplanted to another individual provided host and donor belong to the same inbred strain (isograft).

The various experimental tests are summarized in Figure 5, including also those now in progress.

RESULTS

Tables 1-4, Figures 6-9

ANALYSIS

The induction of axial components of the anal fin suspensorium. Experiments involving partial or complete removal of actinosts from the presumptive gonopodial suspensorium in 10 day old male *Lebistes reticulatus* and *Phalloceros caudimaculatus* result in failure of the overlying gonapophyses to develop normally. Whether the relationship between appendicular and axial structures is one of initial mutual stimulation or whether inducing properties arise independently in the actinosts is not known. The induction apparently occurs early, before the onset of visible changes in structure, as suggested by the appearance of *normal* gonapophyses in *Limia vittata* following removal of the actinosts after these fish had reached one month of age. Ability of the hemal spines to respond to removal of the developing gonactinosts is apparently lost once the

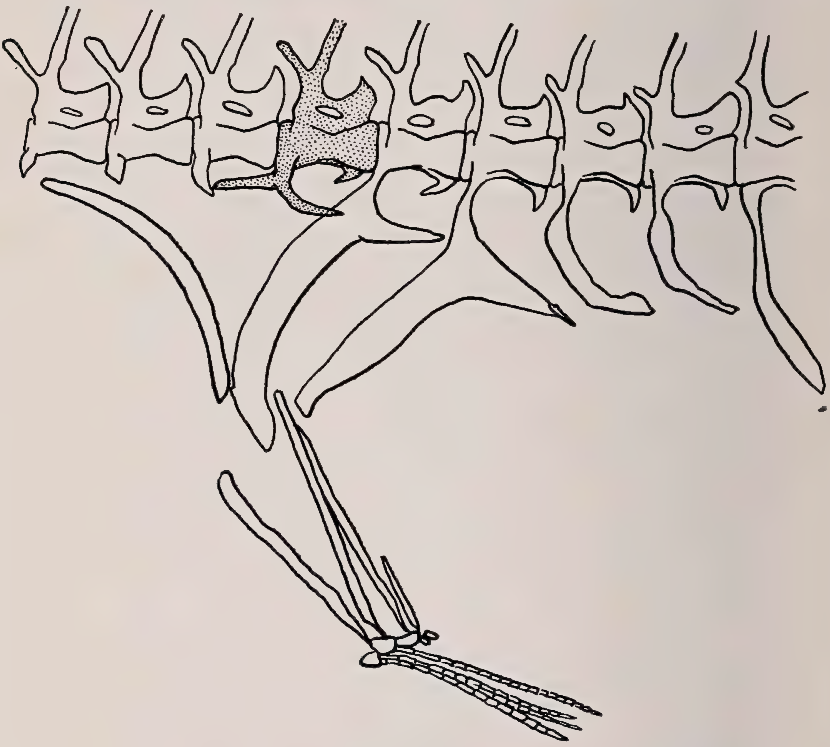

Fig. 6. Gonopodial suspensorium of the South American poeciliid *Phalloceros caudimaculatus* that developed following removal of the anterior actinosts (presumptive gonactinosts 1-5) when the fish was ten days old. Anterior to the left. Gonapophysis I, that supports the missing gonactinost 5, has not developed to its normal size (stippled segment). The free, curved anterior bone is an anomalous ligastyle that appears to have grown in an unrestricted manner in the absence of underlying gonactinosts. Compare with Figure 9B.

TABLE 1

DEVELOPMENT OF GONAPOPHYSES IN THE GONOPODIAL SUSPENSORIUM FOLLOWING COMPLETE REMOVAL OF THE PRESUMPTIVE GONOPODIUM AND GONACTINOSTS IN THREE SPECIES OF IMMATURE MALE POECILIID FISHES

	Age at which operated	No. operated males surviving to maturity	Gonapophysis Development		
			Gonapophysis I	Gonapophysis II	Gonapophysis III *
Lebistes reticulatus	10 days	3	absent (1 case), or present as minute vestigial modified spine (2 cases).	absent (1 case), or present as minute vestigial modified spine (2 cases).	——
Limia vittata	1 month	4	present and normal.	present and normal.	——
Xiphophorus maculatus	10 days	3	present and normal.	present and normal.	present and normal.

* There are only two gonapophyses in the gonopodial suspensoria of *Lebistes* and *Limia*.

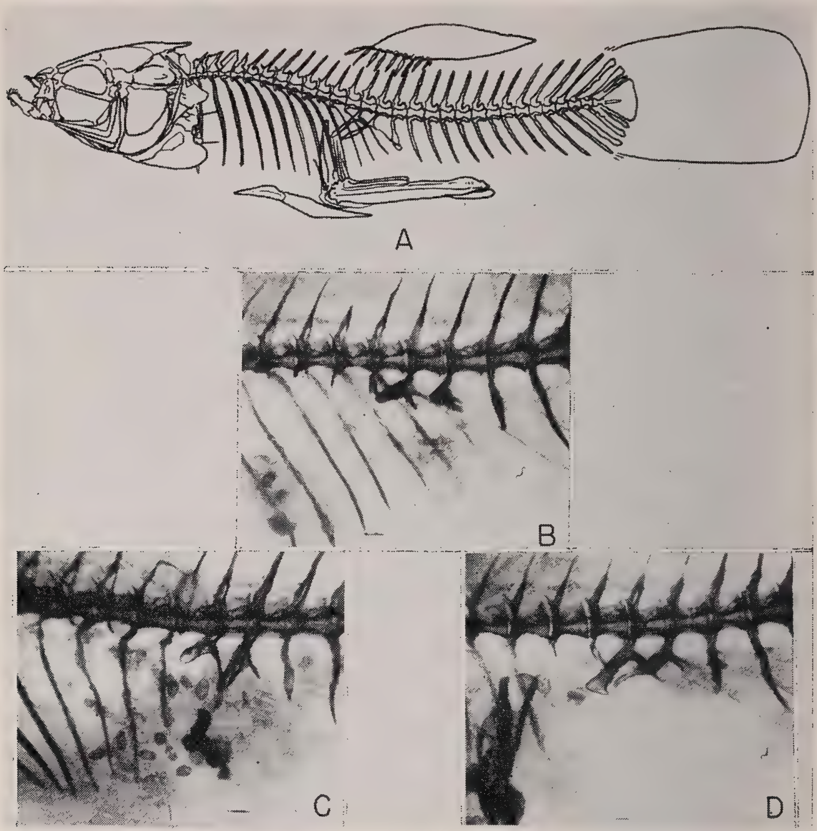

Fig. 7. Development of gonapophyses in the gonopodial suspensoria of the South American poeciliid *Lebistes reticulatus* following complete or partial removal of presumptive gonactinosts from ten day old male fish. A. Skeleton of the normal male (tracing from a radiograph). The two gonapophyses may be seen extending forward and downward from the vertebrae toward the upper margins of the gonactinosts. B. Complete removal of presumptive gonactinosts. The gonapophyses are extremely small, no longer than a single vertebra. C. Partial removal of the presumptive gonactinosts where a small remnant failed to displace anteriorly. The gonapophyses are somewhat larger, the second having grown out in relation to the gonactinostal relict. D. Partial removal of the presumptive gonactinosts where a larger remnant was displaced anteriorly. The gonapophyses are of nearly normal size and have again grown out in relation to the gonactinostal relict.

induction has occurred, and thereafter their delevopment is determined or canalized, although not rigidly (see below). The specific tissue competence to elaborate a gonapophysis appears to be limited, however, to the region of the anterior hemal spines for anal fin transplants to other regions of the body elicit only a non-specific response that is manifested by the polarized growth of bone toward the implanted actinosts. No gonapophysis-like structure has ever appeared ectopically. The developmental competence of the anterior hemal spines to elaborate gonapophyses probably exists within a gradient that falls off rapidly posteriorly. This is indicated by the fact that 1) the anterior gonapophysis is always the most strongly developed, the second much less so, the third when present rather poorly developed, and a fourth (actually the 5th hemal spine) an extreme rarity, and 2) anal fins transplanted to the region of the posterior hemal spines (elements 6 to 8) fail to elicit any save a non-specific growth response.

Replicate experiments involving complete or partial anal fin removal in 10 day old male *Xiphophorus maculatus* reveal that the differentiation of gonapophyses form hemal spines in this species may proceed normally in the absence of appendicular elements. Nevertheless the ectopic transplant of *X. maculatus* actinosts elicits a positive though non-specific growth of bone and therefore also appears to have the capability of inducing osseous growth. It is possible that the gonapophyses of *Xiphophorus* are 1) induced and therefore determined earlier than 10 days after birth, or 2) develop autonomously. In *X. maculatus,* however, the gonapophyses are little specialized and occasionally difficult to distinguish from unmodified hemals, whereas in the other three species these bones are highly specialized and complex. The simpler type of suspensorium in *Xiphophorus* is in many respects like those of oviparous cyprinodonts (Rosen and Gordon, 1953) and is therefore structurally primitive as compared with this system in *Lebistes, Limia* and *Phalloceros.* Perhaps in the evolution of the more complex type of poeciliid suspensorium, control of gonapophyseal growth was gradually taken over by the actinosts as a means of insuring proper timing and structural and functional integration in development.

When the anal fin and actinosts are wholly or partially removed from 10 day or one month old females of these four poeciliid species development of axial elements proceeds normally in all cases. Ec-

TABLE 2

DEVELOPMENT OF GONAPOPHYSES IN THE GONOPODIAL SUSPENSORIUM FOLLOWING PARTIAL REMOVAL OF THE PRESUMPTIVE GONOPODIUM AND GONACTINOSTS IN TWO SPECIES OF IMMATURE MALE POECILIID FISHES.

	Age at which operated	No. operated males surviving to maturity	Position and size of actinostal relict	Gonapophysis Development		
				Gonapophysis I	Gonapophysis II	Gonapophysis III
Lebistes reticulatus	10 days	1	did not migrate forward; minute posterior elements remaining.	present as minute vestigial modified spine.	absent	—
		2	migrated forward normally or nearly so; large portion of primary gonactinostal complex remaining.	absent (1 case) or present as moderately elongate spine oriented toward actinostal remnant (1 case).	absent	—
Phalloceros caudimaculatus	10 days	1	did not migrate forward; posterior elements remaining.	present as minute vestigial modified spine.	present and well developed, but oriented downward toward actinostal remnant rather than strongly forward.	present and well developed, but oriented downward toward actinostal remnant rather than strongly forward.

topic transplants fail to elicit a definitive osseous growth in the site of transplantation such as that seen in males. It is therefore probable that the indictive properties of the developing gonactinosts are expressed only in the presence of the male's physiological environment and may actually be directly stimulated by the rising blood titers of androgen that are being put forth by the maturing testis.

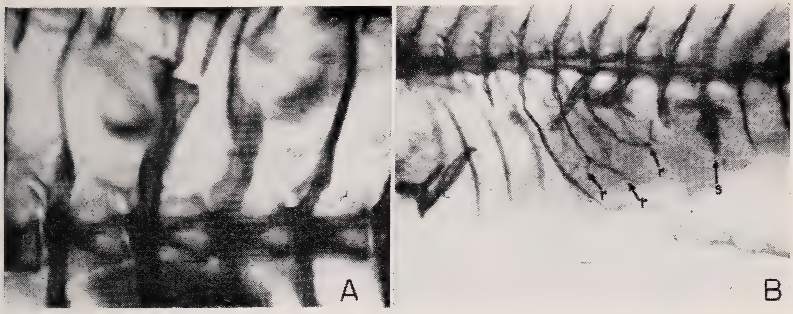

Fig. 8. Experiments showing the non-specific growth of bone resulting from ectopically transplanted presumptive gonactinosts in the regions of A) the neural spines in *Xiphophorus maculatus* and B) the posterior pleural ribs, and a hemal spine arising from the 5th caudal vertebra in *Lebistes reticulatus.* The ectopic transplants have been removed in all cases to reveal underlying modifications. In (A) the two neural spines in center were directly under transplant and show the addition of much bone that projects up toward the observer. A normal neural spine is at right. In (B) the arrows labelled (r) point to bony additions to the pleural ribs, and (s) to an elaborate though non-specific modification of a hemal spine resulting from the implantation directly below it of two separate fragments of presumptive gonactinostal tissue. Gonapophyses have not formed normally in (B) as a result of removal of those portions of the presumptive gonactinosts that were moved to ectopic positions near the pleural ribs and the hemal spine on the 5th caudal vertebra. The remaining gonactinostal tissue has migrated forward and the gonapophyses have grown out in relation to it in a manner similar to that in Figure 7D.

Evocation and individuation of axial components of the anal fin suspensorium. When gonapophyses fail to develop normally following complete removal of the presumptive gonactinosts there usually remain attached to the vertebrae small bony remnants of the hemal spines. These, far from developing simply as a result of histolytic reduction, possess a definite morphology and *appear to have specifically differentiated as vestigial but clearly recogniz-*

TABLE 3

RESPONSE OF POSTERIOR HEMAL SPINES, NEURAL SPINES AND PLEURAL RIBS TO TRANSPLANTED ANAL FINS AND ACTINOSTS IN TWO SPECIES OF IMMATURE MALE POECILIID FISHES.

	Age at which operated	No. operated males surviving to maturity	Position of transplated anal fin and actinosts	Response of bony tissue in region of transplant
Lebistes reticulatus	10 days	2	posterior hemal spines.	histolysis and localized non-specified osteogenesis in region of transplant; *no gonapophysis formation.*
Xiphophorus maculatus	10 days	2	neural spines below dorsal fin actinosts.	localized non-specific osteogenesis in region of transplant.
		22	posterior pleural ribs.	localized non-specific osteogenesis in region of transplant (18 cases); no response (4 cases) in which the transplants were quite small and superficial.

able gonapophyses. When portions of the presumptive gonactinosts are left in place the gonapophyses are somewhat larger, having grown outward in relation to those portions of the actinosts remaining.

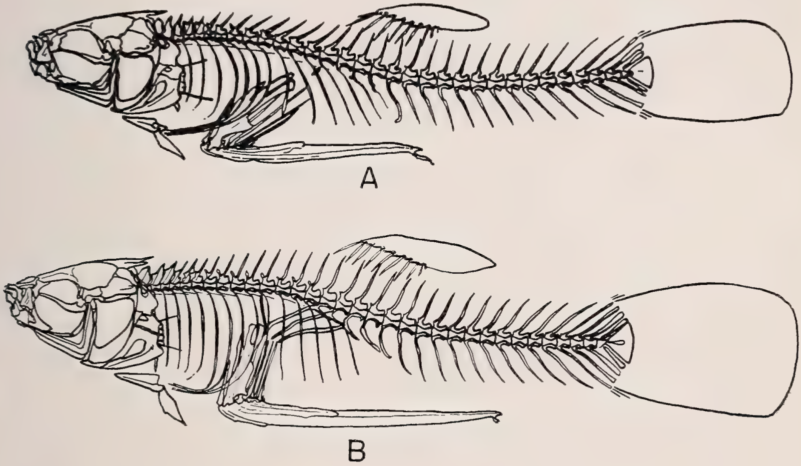

Fig. 9. Skeletons of adult males of the South American poeciliids A) *Cnesterodon decemmaculatus* and B) *Phalloceros caudimaculatus.* Tracings from radiographs. Note that the anal fin origin is farther forward and that no gonapophyses are present in *Cnesterodon.* In both, however, the pleral ribs are highly modified, having enlarged and grown forward to serve a suspensorial function. The functional relations of the gonopodial suspensorium and pleural ribs in *Tomeurus gracilis* (Figure 3) are almost identical to those of *Cnesterodon.*

Waddington, Needham and Schmidt (see Waddington, 1956: 188) suggest that induction is in many instances a composite of two distinct processes, one (evocation) that calls forth a response in some other structure (and this need not be specific) and another (individuation) causing a definite pattern formation in the induced structure. Such a distinction seems appropriate to the present material. For example, the presumptive gonactinosts appear to do nothing more than elicit a response to osseous growth; gonapophyses not so induced fail to grow to their normal size but show nevertheless the ear-marks of normal pattern formation and are therefore probably self-individuating.

The actinosts of the structurally primitive *X. maculatus,* however, even though capable of evoking osseous growth, apparently

TABLE 4

DIRECTION AND TYPE OF GROWTH OF ANAL FINS AND ACTINOSTS REVERSED *IN SITU* IN IMMATURE MALE *LEBISTES RETICULATUS*.

Age at which operated	No. operated males surviving to maturity	Polarity and growth of anal fin rays		Polarity and growth of anal fin actinosts	
		Originally posterior elements	Originally anterior elements	Originally posterior elements	Originally anterior elements
10 days	1	no response	no response	no response	no response
	2	direction of growth reversed; forming atypical gonopodium.	direction of growth reversed; assuming form of simple posterior elements.	direction of growth reversed; forming primary gonactinostal complex	direction of growth reversed assuming form of simple posterior elements (1 case) or differentiating abortively as primary gonactinostal complex (1 case).

have not become developmentally integrated with axial elements which in this species differentiate largely if not completely autonomously. The necessary role of an evocator in more specialized forms, by sharing the responsibility of gonapophysis formation, appears to have made possible a greater flexibility in development.

The developmental environment. The inductive forces are at work within an antero-posteriorly polarized gradient. This is suggested above by the gradually diminishing competence of hemal spines to elaborate gonapophyses posteriorly. It is more clearly demonstrated, however, by the experiments involving *in situ* anal fin reversals.

In its normal position, the anal fin points posteriorly and is supported internally by large anterior and smaller posterior actinosts. When reversed in 10 day old male fish (Table 4) the large anterior elements are posterior and the fin rays are directed anteriorly. As the fish grows, the fin rays turn about and both the originally posterior fin rays and actinosts abortively assume the form of anterior elements (gonopodium and primary gonactinostal complex respectively). The now posterior presumptive primary complex does undergo some differentiation suggesting that when reversed it had already been at least partly determined.

Superimposed on all of the above factors are the little understood characteristics of growth and pattern formation that under normal conditions result in the harmonious integration of fin rays, actinosts and hemal spines into a functioning mechanism. Rosen and Bailey (1959) called attention to the fact that size and form of many bones in the gonopodial suspensorium are influenced by slight variations in their positional relationships and absolute size of the fish. Experimentally this may be demonstrated by the effects on gonapophysis development of the extent to which relicts of extirpated anal fin actinosts migrate forward during the male's maturational changes. When these relicts fail to migrate the developing gonapophyses grow almost vertically downward toward them. When they have shifted forward slightly the gonapophyseal angle increases in relation to this shift. In the normal male, in which the actinosts have been displaced considerable forward the gonapophyseal angle is quite sharp.

DISCUSSION

Development and evolutionary significance of variations in the number of gonapophyses in species of Poeciliidae. The majority of poeciliids have three gonapophyses in their gonopodial suspensoria, and a few individuals occasionally have four (*Gambusia, Poeciliopsis, Xenodexia*). All species of *Poecilia*-like fishes (*Lebistes, Limia,* etc.) and some *Gambusia* typically have two. *Alfaro* has two, three or four. In *Tomeurus* and *Cnesterodon* gonapophyses are absent, although other elements of their gonopodial suspensoria are typical of those of poeciliids in general. An analysis of the morphological details of the gonopodium, gonactinosts, head squamation, and osteocranium suggest that *Poecilia*-like fishes and *Cnesterodon* are each most closely allied to genera the members of which have typically three well developed gonapophyses (Rosen, Ms.).

The resemblance between *Cnesterodon* and *Tomeurus* may be attributed to parallel evolution.

These observations prompt the following questions:

1) How do differences in number of gonapophyses arise among closely related genera and species?

2) Are the developmental pathways leading to the reduction of one *vs.* all gonapophyses fundamentally the same or different?

3) What is the adaptive significance of reduction in gonapophysis number and the explanation for its having evolved independently four times in this family?

If there exists an inductive relationship between presumptive gonactinosts and gonapophyses, as is suggested by the above experiments, then differences in gonapophysis number could arise by 1) a diminution of the evocating properties of the actinosts (that is, a reduction in potency and/or extent of the morphogenetic field arising from the actinosts), 2) changes in the relative positions of actinosts and hemal spines such that the hemal spines contact this field at its periphery or not at all, 3) a gradual loss of competence of the hemal spines to respond to the indictive stimulus, 4) alterations in the time of first appearance of histolytic processes and/or the inductive stimulus for bone growth, or a lag in response to the osteogenetic stimulus, that allows histolysis to proceed unchecked, and 5) some combination of these. The probable complexity of the inductive relationship between axial and appendicular components of the gonopodial suspensorium indicates that on the basis of present information we can not possible decide in any one case, e.g., *Cnesterodon vs. Phalloceros* (Fig. 10), which factor or combination of factors has been of primary importance. In the example of these two South American genera, the very advanced anal fin insertion in *Cnesterodon* suggests that a loss of contact of the anterior hemal spines with an inductive stimulus from the actinosts has at least been involved in the loss of gonapophyses in this genus. That the anterior hemal spines of *Cnesterodon* are capable of differentiating into gonapophyses is suggested by Philippi's (1909) discovery of vestigial gonapophyses in some individuals of this form (his Figure G, p. 58). These vestigial structures are precisely like those induced experimentally in the closely related genus *Phalloceros* by partial extirpation of the anal fin actinosts (Fig. 6).

Rosen and Gordon (1953) pointed out that one of the primary events in poeciliid evolution may have been the gradual displacement of the male's modified anal fin anteriorly. Rosen and Tucker (Ms.)[4] suggest that the anterior shift of the gonopodium brings it into alignment with the fish's center of gravity and visual field, thus enabling the fish to exercise more complete control over its use during the complex mating maneuvers. Anterior displacement of the anal fin would seem to be possible only in those forms in which initially gonapophysis development came under partial actinostal control to insure proper integration of axial and appendicular elements. Our experiments indicate that such regulative properties presently exist only in those forms (*Lebistes* and *Phalloceros*) in which the anal fin is rather far forward and the gonapophyses are bent and drawn out anteriorly to interdigitate with the transposed actinosts. In at least some instances the highly adaptive forward shift of the appendicular elements may have resulted in the gradual secondary loss of this inductive relationship e.g. in *Cnesterodon* and *Tomeurus* in which gonapophyses are absent. In this way, the development of a complex gonapophyseal system appears to be transitional between the least and most specialized suspensorial conditions. Whereas the origin of complex gonapophyses supplied the wherewithall for increasing specialization and was therefore highly adaptive, the subsequent deletion of one or more gonapophyses, being incidental to the evolution of a more efficient mechanism for sperm transfer, may represent in itself a non-adaptive change.

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[4] Evolution of secondary sexual characters and sexual behavior patterns in a family of viviparous fishes (Cyprinodontiformes, Poeciliidae).

It is our opinion that the transition from a system with gonapophyses, to one without, could not have taken place in a single step. As the anal fin insertion was gradually advanced[5] the elimination of the principal means of axial support of the gonopodium must have occurred apace by the gradual loss of one, two and then three gonapophyses to allow time for new means of axial support to be established. In *Cnesterodon* and *Tomeurus* missing gonapophyseal support apparently is compensated by extensive connective tissue bridges between the gonactinosts and the vertebrae and pelvic girdle, and by further modification of the sexually dimorphic pleural ribs for a suspensorial function. Many poeciliids, and especially cnesterodontins such as *Phalloceros,* have extremely advanced anal fins and sharply bent and attenuate gonapophyses and seemingly are themselves on the threshold of such a transition. The process may already be under way in *Poecilia*-like fishes and some *Gambusia.* For this reason we do not regard the absence of one or all gonapophyses *per se* as being an adequate criterion of phylogenetic position among Poeciliidae. The absence of these structures is certainly less important phylogenetically than their form and orientation when they are present, even though their appearance be a rare spontaneous occurrence or the result of experimental interference.

Summary

Internal fertilization is made possible in poeciliid fishes by the development in the male of a modified anal fin (external genitalium or gonopodium) that is supported internally by a complex series of appendicular and axial bones. The internal elements (gonatcinosts), articulating directly with the pivotal bones of the fin rays, carry the muscles that activate the fin. The gonactinosts are anchored firmly to the sexually modified hemal spines (gonapophyses) that project downward from the vertebral axis. In the course of revisional work many apparently closely related genera and species were found to differ in the presence or absence of one or all of the normal complement of gonapophyses in their gonopodial suspensoria. The adaptive significance of the loss or reduction of gonapophyses was not clear, but it was noted that the anal fin of species lacking these structures is inserted farther anteriorly than in species with them. Because those species lacking gonapophyses have their anal fins displaced unusually far forward in relation to the anterior hemal spines, it was suggested that the developing appendicular elements in some way determine the presence or absence of, and growth and form of neighboring axial structures.

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[5] During gonopodial and suspensorial development, the anal fin moves forward in relation to the anterior hemal spines. This shift during ontogeny is the result of 1) slower rate of growth of tissues in the region of the pelvic and anal fins in relation to body growth, and 2) an actual constriction o ftissues between the pelvic and anal fins that brings these two fins closer together (based upon measurements of a graded size series of young ,subadult, and adult specimens of *Limia caudofasciata* from Jamaica). Thus, the evolution of an anteriorly inserted anal fin must have been further complicated by the necessity of first establishing a special growth pattern and a reorganization of ventral tissues.

Experiments involving extirpation and transplantation of the presumptive gonactinosts suggest that in the more specialized poeciliids these elements provide an inductive stimulus essential for normal development of the overlying gonapophyses. In the more generalized forms this induction effect is not apparent.

Evidence is presented indicating that the origin of an inductive relationship between axial and appendicular elements paved the way for one of the major events in poeciliid evolution involving a pronounced shift forward of the anal fin in the body. In the structurally most advanced poeciliids the anal fin is displaced so far forward that the inductive relationship, depending partly on the proximity of axial and appendicular elements, has been secondarily lost; gonapophyses fail to develop. It is suggested that the deletion of one or more gonapophyses, being incidental to the evolution of a more efficient mechanism for sperm transfer, may represent in itself a non-adaptive change.

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Literature Cited

KALLMAN, K. D., and M. GORDON

1957. Transplantation of fins in xiphophorin fishes. Ann. New York Acad. Sci., 71(3): 305-320.

1958. Genetics of fin transplantation in xiphophorin fishes. *Ibid.,* 73(3): 599-610.

PHILIPPI, E.

1909. Fortpflanzungsgeschichte der viviparen Teleosteer *Glaridichthys januaris* und *G. decem-maculatus* in ihrem Einfluss auf Lebensweise, makroskopische und mikroskopische Anatomie. Zoologische Jahrbücher, 27: 1-94.

ROSEN, D. E.

1959. Evolutionary significance of the axial and appendicular skeletons of viviparous cyprinodonts (Pisces). Anat. Rec., 132(3): 496-497.

ROSEN, D. E., and R. M. BAILEY

1959. Middle-American poeciliid fishes of the genera *Carlhubbsia* and *Phallichthys,* with descriptions of two new species. Zoologica, 44(1): 1-44.

ROSEN, D. E., and M. GORDON

1953. Functional anatomy and evolution of male genitalia in poeciliid fishes. Zoologica, 38(1): 1-47.

WADDINGTON, C. H.

1956. Principals of embryology. The Macmillan Co., New York, pp. 510.

Quart. Journ. Fla. Acad. Sci. (1959), 22(4), 1960.

SIR THOMAS BROWNE (1605-1682), DEBUNKER OF POPULAR SUPERSTITIONS

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One aspect of our day that the social historian can not fail to note is the popular passion for so-called "facts," bits of information, reliable or unreliable, related or unrelated. Witness the plethora of quiz programs, the adulation that for a time was given Charles Van Doren, the excitement over the "Sixty-Four Dollar Question." Witness also the multitudinous magazine articles which ask solemnly, "Does lightning strike twice in the same place? Are brown eyes stronger than blue? Can hair turn gray overnight?"

Who started this habit of inquiry, of zeal for quaint and curious bits of truth, of exposing the false notions of the populace? So far as I know, the first to raise such inquiries, at least to any great extent in the English language and for popular consumption, was the metaphysical doctor, Sir Thomas Browne (1605-1682), whose *Pseudodoxia Epidemica* (*Common Errors*) looks into some of the favorite superstitions and pseudo-science of his day. He is worthy of our attention because of the nature of his material and the curious and at least occasional modernity of his approach.

"What is truth?" says the serious doctor and stays at length to make his own answer. Such an attitude is in contrast with that of most of his predecessors, who frequently are off on allusions to the "stone Asbeston," the peculiar ways of salamander or amphisbaena, or perhaps medicines to win women, such as "the lungs of a Vulture . . . the tongue of a Goose, the brayne of a Cat, and the last hair of a Wolves taile." (Lyly, I, 116) Moreover, Aristotle's opinion was still spoken of with bated breath as "*Ipse dixit.*"

To be sure, the *Pseudodoxia Epidemica* is certainly not a compendium of reliable information. Yet the author's very earnestness induces the feeling that in his person a new prophet arises in the field of lapidary, botanical, and zoological lore. True, for a modern reader, the solemnity of his approach seems out of proportion to the triviality of some of his material. His dignified introduction is in the tone of one who would negate the law of gravity, or who would prove Copernicus a cheat, Darwin a dolt, and Einstein a moron. By contrast, some of his statements have the tone of Barnum's yokel who exclaims, "There's no such animal!"

At any rate, the more or less scientific method of the author is refreshing. To begin with, he at least thinks his method is modern. It is a seriously inquiring manner, no Everlasting Yea nor Everlasting Nay, but rather an eternal "*Warum?*" Like the dying Cyrano, he flashes his brand against all "ancient sillinesses."

Furthermore, he apparently foresees and forestalls a storm of disagreement. For carping, uninformed critics, who "fallaciously or captiously refute us," merely "laying hold upon lapses," i.e., pouncing upon small details, he has no time to spare. But he will gladly take notice of those whose intention is not "to traduce or extenuate, but to explain and dilucidate, to add and ampliate." (Browne, I, 119)

Another modern note appears in the idea that really to discover and discern truth, one must make his mind a *tabula rasa*; "to purchas a clear and unwarantable body of truth, we must forget and part with much we know." (Browne, I, 115)

Furthermore, he is modern in that he does not wish to monopolize human knowledge, but he will leave certain aspects of his subject untouched. For example, in the analysis of the beginnings of error, he leaves some aspects to the moralist, some to the Thalmudist, some to the lawyer, and some simply "to God." One strikingly worded poser is assigned to the schoolmen (the hair-splitters), namely, "Whether the resistibility of Adam's reason did not equivalence the facility of Eve's seduction." (Browne, I, 119)

Like a modern scientist, he does not shun reality, nor does he deny the existence of evil and error. This error that he finds all about him he defines as "a false judgment of things, or an assent unto falsity."

Before plunging into his encyclopedic list of "vulgar errors," the author passes from his analysis of the first cause of error, namely, sin in Eden, to the second cause, the erroneous disposition of people. Adam not only sinned, but he left his heirs a proneness to wander from the truth. The second cause is sub-divided into Misapprehension, Fallacy or False Deduction, Credulity, Supinity, Adherence to Antiquity, Tradition, and Authority.

All these have concrete illustrations. For example, an instance of fallacious deduction is the literal interpretation of Pythagoras' command, "Abstain from beans." What he really means is "Do not run for office," since magistrates were elected by beans as ballots in some parts of Greece. The "fallacy of the consequent," or assuming a cause and effect relation where none exists, appears in the Pharisees' denying the holiness of Jesus because he conversed with publicans and sinners. Credulity is aptly defined as "a believing at first ear what is delivered by others," and Supinity as "rather believing than going to see."

The "mortallest" enemy in the list is the resignation of our judgments to any author or age whatsoever. Remember, he says, that Aristotle himself questioned the past and did not regard himself as *ultimum verbum.* Times past were once times present. He implies that Aristotle and Plato were once, as Emerson was to say later, only "young men in libraries." Such slavish appeal to tradition turns the back on nature. Moreover, much ancient "knowledge" can be corrected by critical and collective reason and observation. An argument, such as Aristotle's "why man alone hath gray hairs," is obviated since horses, dogs, and foxes all have been *observed* to have gray hairs.

Thus, having cleared the ground, he persistently subjects most of the errors to two questions: Is the belief consonant with reason? And is it "correspondent with experiment?" The three "determinators of truth," he argues, are authority, sense, and reason. (Browne, I, 326) By authority, he usually means the testimony of eye-witnesses and experimenters who have arrived at the truth empirically.

For his method, see his dissertation on the elephant in the third book. There had been an "old gray-headed error" that the elephant "hath no joints" and that, being unable to lie down, it leans against a tree to sleep, "which the hunters observing do saw almost asunder." Thereupon the elephant falls down; and being down, he can rise no more. But, reasons the author, how can an elephant *walk* without joints? Even though moving serpents, worms, and leeches lack bones and "all extended articulations," they have "arthritical analogies." Hence the first conclusion: the belief is contrary to reason. Further, records testify to the elephant's performing actions performable only with joints. He cites "that memorable shew of Germanicus, wherein twelve elephants danced unto the sound of music, and after laid them down." (Browne, I, 311) Hence, secondly, the evidence of history contradicts the belief. Finally, experience is against it; for an elephant was exhibited in England "not many years past," not only standing but kneeling and lying down. Thus does the formula—Reason, Authority, Experience—forecast our present devotion to Hypothesis, Experiment, Conviction.

Experience should perhaps have had a greater portion in Sir Thomas's humorless discussion of the badger and the common belief that "the badger hath the legs on one side shorter than on the other." Again authority, sense, and reason are arrayed against error. Among the "total set of animals," he urges, we observe in their legs "equality of length and parity of numeration." If we assign equality to the badger's legs, he suggests, such inequality would be more reasonable if "placed upon the thwart or diagonal movers"—in other words, the cross legs. This strange statement seems to say that a right fore leg and a left hind leg could be made to match—in which case the last state of the badger would probably be worse than the first. Such theorizing, it must be admitted, illustrates an incredible neglect of the laboratory method. Surely there were badgers that could have been caught and measured. According to Sir Edmund Gosse, Dr. Edward Browne, a son, on December 10, 1664, did dissect a badger. Since he was then living at his father's house in Norwich, probably the father assisted at the demonstration. (Gosse, p. 82)

Sir Thomas is not so theoretical about another observable animal, the frog. With the conviction of a real biologist, he has "included the spawn with water in a glass" and with his own eyes has beheld the evolution of the "porwiggle" or tadpole into the "perfect frog." He adds that the belief that a frog may be easily drowned is destroyed by experiment; for "fastning one about a span under water, it lived almost six days." (Browne, II, 18)

One of the most interesting chapters, Book III, Chapter xxvi, concerning observable animals is that "Of Sperma-Ceti and the Sperma-Ceti-Whale." Spermaceti was a mystery to philosophers. It was believed to be a *flos maris,* or a bituminous substance floating upon the water, or even the spawn of the whale. But a sperm whale was cast upon the English shore at Hunstanton, which Sir Thomas undoubtedly dissected. Though the whale had been dead "divers days" and was "under putrefaction," the anatomist records, "The Magazin of Spermaceti was found in the head, lying in folds or courses, in the bigness of goose eggs, encompassed with large flakie substances, as large as a man's head, in the form of honey-combe, very white and full of oyl." (Browne, II, 86) The "insufferable fetour" prevented inquiry into the "strange composure of the head, and the hillock of flesh about it" as well as the content of bladder and stomach. Into this display of scientific curiosity intrudes the artless sentence, "And this (the Physiter) may conceive to have been the fish that swallowed Jonas."

In the field of popular fabulous animals Sir Thomas walks with more timid steps. Here he must argue from negation, for no table book can definitely record that amphisbaena does not have a head at each end and that a salamander can not be shaved to furnish a non-combustible wool. Besides, there was scripture. Had not the holy prophet Isaiah spoken of hatching cocatrice's eggs? And did not Job mention the Phoenix? Considerable space is devoted to the latter. This is a creature of fame and beauty, only one of which lives at a time until its life cycle is completed. Then it dies upon a perfumed pyre of its own making to rise from the flames in new splendor. The "unity" of the bird seems to disturb the author greatly, for the concept is not only "repugnant to philosophy but to the holy scripture." Did not Noah take two of all living things into the ark? And did not Jehovah expressly command the animals in Eden to increase and multiply? How then could a bird of such single blessedness obey that injunction? And would a just creator command even a bird to do something impossible? His final Q.E.D. has no flourishes. Since the concept hath "neither reason nor experience to confirm it, how far to rely on this tradition, we refer unto consideration." (Browne, II, 11-12)

Another type of error that annoyed Sir Thomas Browne was that propagated by pictures drawn or painted without regard for truth. Consider, for example, the picture of Cleopatra dying "with two asps under her arms or breasts or both." Here his reasoning, though lucid, indeed signifies little. Cleopatra's infinite variety is only a mummy; and whether she passed to immortality by one asp or two asps or no asp at all is not a matter to disturb the slumbers of any century. In the first place, he says, no one knows the actual manner of her death; it might even have been from poison secreted in a comb. Further, there were never any asps discovered in the place of her death. The two small pricks on her arm may have been made by her own teeth, as opening a way to pour in poison.

The length of the asps may be questioned (if any) and the place where they were applied. Herein appears an almost unbelievable disregard of all imaginative license for the sake of art.

In this section appears a rather enlightened view of scriptural interpretation in the attack on the picture of Jephthah portrayed in the act of sacrificing his only daughter. The "death," he asserts, may not have been natural, but "civil," not cessation of life, but a "separation unto the Lord." Both text and reason are called on for support. As to the text: She bewailed her virginity, not her life or death. (This means, of course, not that she bewailed a loss of virginity, but she bewailed that she did not lose it in marriage.) The Israelitish girls went yearly to talk with the daughter of Jephthah four days of the year. Even the rendering "lament" signifies to "talk or have conference with one." As to reason: God abhorred human sacrifice. The offering encroached not only on religion but on discretion, for there was possibility of legal evasion. The vow was concerned with "whatsoever shall come forth" and could reasonably refer only to what was *sacrificable.* Where there is possibility of doubt, the author chooses the interpretation least derogatory to the Bible. Perhaps Thomas Browne felt, as Thomas Paine did later, that some of the doctrines of scripture, if taken literally, are really derogatory to the Almighty. This attitude seems significant; for though Erasmus had said that parts of scripture may be interpreted as a "popular poem," not many were ready to admit any old gray-haired error in Biblical interpretation.

Thus the melange of mediaeval and modern goes on apace. At any moment the author seems likely to embark upon a learned disquisition on some such question as which comes first, chicken or egg. Let not his modern motive, however, be forgotten or despised. It is to furnish criticism, cathartic, and clarification for the intellect of the average man.

Literature Cited

BROWNE, SIR THOMAS
1904. *Works,* ed. Charles Sayle, Macmillan, New York: Vols. I and II.

GOSSE, EDMUND
1905. *Life of Sir Thomas Browne,* Macmillan, New York.

LYLY, JOHN
1903. *Works,* ed. R. W. Bond, Oxford, Vol I

Quart. Journ. Fla. Acad. Sci. (1959), 22(4), 1960.

RADIOACTIVE MONITORING AND ENVIRONMENTAL HEALTH

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The problems of the "atomic era" are universal and can be expected to affect everyone. As the use of radioactive material increases, the problems of population exposure and environmental contamination also increase. The maximum permissible concentration (mpc) of the various radioisotopes in air and water were established by the International Committee for Radiation Protection and based on genetic effects, and not pathological effects.

Up to now the pollution of our environment with radioactivity has been considerably below the mpc, however, the "atomic era" is in its infancy. Much of the fall-out data made public to date has been used by the press in sensationalistic articles that produced public fear of radioactivity. This fear combined with the actual hazards to health make the problems of monitoring for radioactivity more acute. Establishing an operating such a monitoring program has become the responsibility of the laboratories concerned with public health. Monitoring should be considered a necessary part of the sanitary control of environmental conditions just as bacteriological determinations are now employed to monitor water treatment operations.

Weapons testing, research, medical and industrial uses of radioactive elements have released considerable quantities of radioactivity into the environment. Part of this activity returns to the earth in the form of "fall-out" or "rain-out" and finds its way to water and food supplies. This possible hazard emphasizes the need for establishing a routine monitoring program for measuring this radioactive pollution. During the next decade the use of radioisotopes will increase for use in power reactors, therapeutical purposes and in research which will consequently increase the amount of radioactive wastes released into the environment. Initiatiton of monitoring programs at that time will not ascertain the normal background values that now exist.

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A monitoring program was established four years ago at the Phelps Laboratory for Sanitary Engineering Research. This program is not complete but does give adequate information for most purposes.

Monitoring Survey

This monitoring program includes the sampling of air, surface waters, public water supplies, sewage, rain, soil and vegetation. Samples are taken daily of the Gainesville water supply and Gainesville sewage, University sewage and the air. Eleven surface waters and ten other public water supplies in Alachua County are sampled at monthly intervals. All rain is sampled and soil and vegetation are sampled 6 to 8 times yearly.

Analytical Procedures

a) Surface water supplies: A 250 ml portion of each sample is dried. The residue is moistened with several drops of 1 N hydrochloric acid and quantitatively transferred to a counting pan. After the acid moistened residue plus the washings are dried on the counting pan a few drops of 0.1% lucite are added as a binding agent.

b) Sewage: Aliquots of sewage are selected so that the dried residue will not amount to more than 5 mg/cm^2 on the counting pan. This sample density reduces self-absorption (shielding effect) of the radioactivity by the sample itself.

c) Ground water supplies: Untreated samples of ground water supplies are prepared for examination by the same procedure as that for surface water supplies.

d) Air: Air is passed through a filter at the rate of 10 liters per minute to remove the particulate matter. These filters have an effective porosity of 0.25 microns. The filter is located on a 35 foot tower to reduce the effects of localized dust. Filters are collected and the entire filter counted at 24 hour intervals.

e) Rain: Rain is collected in a polyvinyl coated rain gauge. Volumes of rain up to 500 ml are dried and the residue transferred by the same procedure as that for surface water.

f) Soil: A layer of soil ½ inch thick and ¼ square foot in area is collected and dried. The sample is then mixed and a 100 g aliquot is extracted with 1 N nitric acid. The extract is dried, redissolved in distilled water and the solids content determined. A measured volume of the extract is dried on the planchet for radioanalysis.

g) Plants: New growth of plants are collected for monitoring purposes because the mineral exchange is most rapid in this part of plants. The plant samples are dried and ground and a series of samples prepared to have sample densities of 5, 10 and 20 mg/cm^2. Results from these samples are used to extrapolate the activity at a sample density of 1 mg/cm^2.

Expression of Results

Surface water supplies, ground water and sewage are reported as micro-microcuries per liter. Radioactivity in rain is reported as micro-microcuries per liter and micro-microcuries per square meter. Soil and plant activity is reported as micro-microcuries per gram of dry sample. Radioactivity in air is reported as micro-microcuries per 100 liters.

Radio-analysis

To avoid the effects of radon daughter products samples are allowed to decay for 6 to 8 hours. These samples are then examined for alpha and gross radiations using an internal proportional flow counter. Alpha radiations are counted for 15 minutes if the activity is less than 200 counts per minute or for 5 minutes if the activity is greater than 200 counts per minute. Samples examined for gross radiations (alpha, beta and gamma) are counted for 2,500 counts above background or 30 minutes. This procedure establishes a confidence limit of 95 per cent or 1.96 standard deviations. Total counts are corrected for technical non-conformities, such as detector efficiency, back-scattering, self-absorption and geometry which is used to convert counts per minute to disintegrations per minute. These data can then be converted directly to micro-microcuries by dividing by 2.2.

Laboratory Facilities for Radioactive Measurements

A special radiological laboratory and counting room is provided for monitoring. The materials used for the construction of the counting room were checked for natural radioactivity. This counting room was constructed so that shielding equal to 18 inches of concrete is provided on all six sides. The laboratory and counting room are maintained at a temperature of 75° F. and a relative humidity of 75 per cent. Experience has indicated that humidity and temperature control decreases equipment failure as much as 60 per cent.

Two internal proportional flow counters with automatic sample changers and print-out timers are used for determinations of radioactivity. These instruments make approximately 50 radioactivity determinations per day.

Although elaborate facilities for monitoring are desirable, a sound and thorough monitoring program can be established with far less. Isolated quarters with shielding, so far as practicable, and with controlled temperature and humidity are necessary for accurate low level counting. An internal proportional flow counter with two scalers along with ancillary equipment is the minimum that should be provided. It is futile to try operating a monitoring program with one scaler since breakdowns are inevitably frequent.

Calibration Sources

The selection of a standard calibration source which would be acceptable to all researchers has presented a serious problem. Without such a standard, results from different laboratories cannot be compared. Thallium-204, natural uranium and radium D + E have been used widely as standard sources.

Thallium-204 has the advantages that it can be obtained as a calibrated solution and emits a pure beta ray of 0.765 mev. This isotope has the disadvantage that it can only be used as a standard for comparing energies of a comparable level. For monitoring purposes this makes thallium-204 unsatisfactory because radioisotopes that emit low level beta rays and gamma rays of all energy levels will be encountered. Another disadvantage is the relatively short half-life of 4.0 years.

Natural uranium has a long half-life of about 9 billion years which is favorable for a standard source. Freshly processed uranium contains 99.29% U-238 and 0.71% U-235. Uranium-238 produces the daughter U-234 which has a half life of 24.6 days. Uranium standards that are over 6 weeks old will have reached equilibrium with its daughter products and then remain constant. One disadvantage of using natural uranium is that standards prepared in different laboratories vary because of slight differences in composition.

Perhaps the most satisfactory standard for monitoring is the RaD + E standard. These sources can be obtained as certified sources mounted on palladium-clad silver discs. This standard source gives a wide spectra of alpha, beta and gamma energies. One disadvantage of this source is the 22 year half-life, however, most standard sources are supplied with a decay curve. All data collected at the Phelps Laboratory is compared with National Bureau of Standards certified RaD + E sources.

When a monitoring program is established to detect a single or a known group of radioisotopes the detector should be calibrated with standards having emissions of the same energy level. For example, if iodine-131 is to be the object of a monitoring program the detector should be calibrated with an iodine-131 standard or a mixture of radioisotopes that give equivalent emissions.

For general monitoring a standard should meet the following specifications:

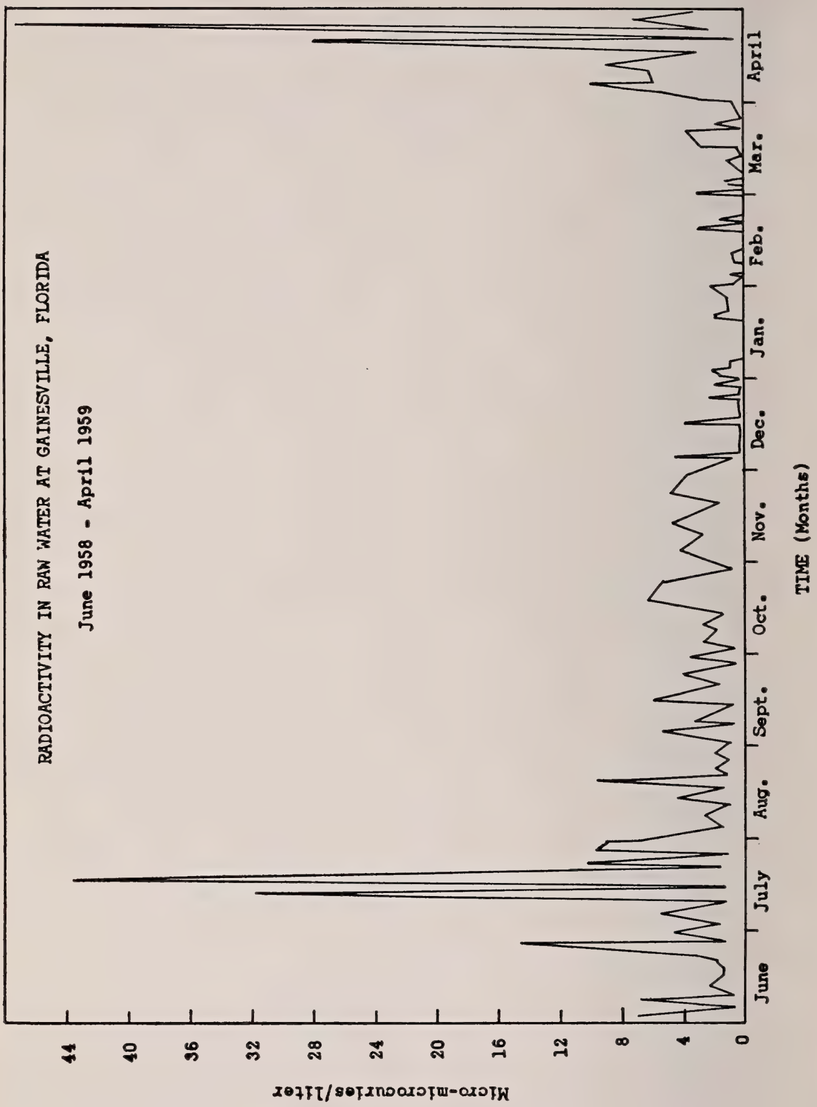
1. the half-life should be accurately known and preferably long
2. the radiations from the standard source should be primarily low energy levels (0.10 to 0.50 mev.)
3. The standard source should be sealed to prevent loss by scratches, evaporation, etc.

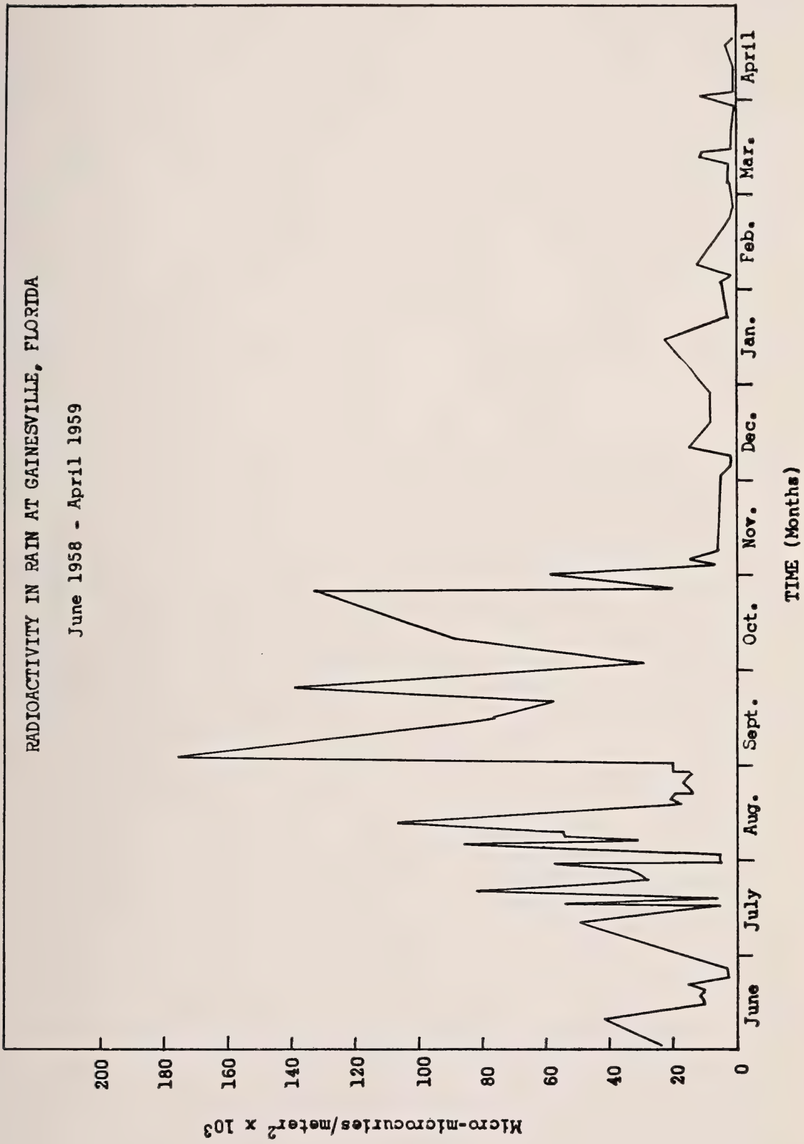
Interpretation of Data

An essential part of any monitoring survey of radioactivity is the maintenance of complete and accurate records of all observations and determinations. This makes data available to assess the significance of radioactive conditions in the environment.

The interpretation of the results of radiological determinations associated with a monitoring program must be based on a full understanding of the principles of nuclear science and on an appreciation of the limitation of the counting equipment and of the sampling procedures.

Definite conclusions as to the significance of the radioactivity detected in given samples must be based on a determination by radiochemical analysis of the specific isotope or isotopes present. In general only the amount of gross activity found can be considered. If this is greater than the tolerance levels prescribed for the particular material under examination this fact alone can be noted and reported. The importance of even small increases in radiation


RADIOACTIVITY IN RAW WATER AT GAINESVILLE, FLORIDA
June 1958 - April 1959
Micro-microcuries/liter
0
4
8
12
16
20
24
28
32
36
40
44
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
April
TIME (Months)


RADIOACTIVITY IN RAIN AT GAINESVILLE, FLORIDA
June 1958 - April 1959
Micro-microcuries/meter² x 10³
0
20
40
60
80
100
120
140
160
180
200
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
April
TIME (Months)

above the normal background amounts in air, water, sewage and other materials cannot be disregarded and should be the basis for more extensive investigations.

Results of the monitoring survey during the period June, 1958 to April, 1959 have been tabulated in Figures I, II and III. This type of graphical representation is an aid to the interpretation of results because marked variations from normal trends in radioactive intensities are definitely indicated. A review of Figure I shows the effects of weapons tests during the period November, 1958 to April, 1959 shows the effects of weapons testing plus the effects of a drought period. During this period southwest winds brought dust from the University of Florida farms. This resulted in contamination by the naturally occurring radioisotopes radium, thorium and uranium.

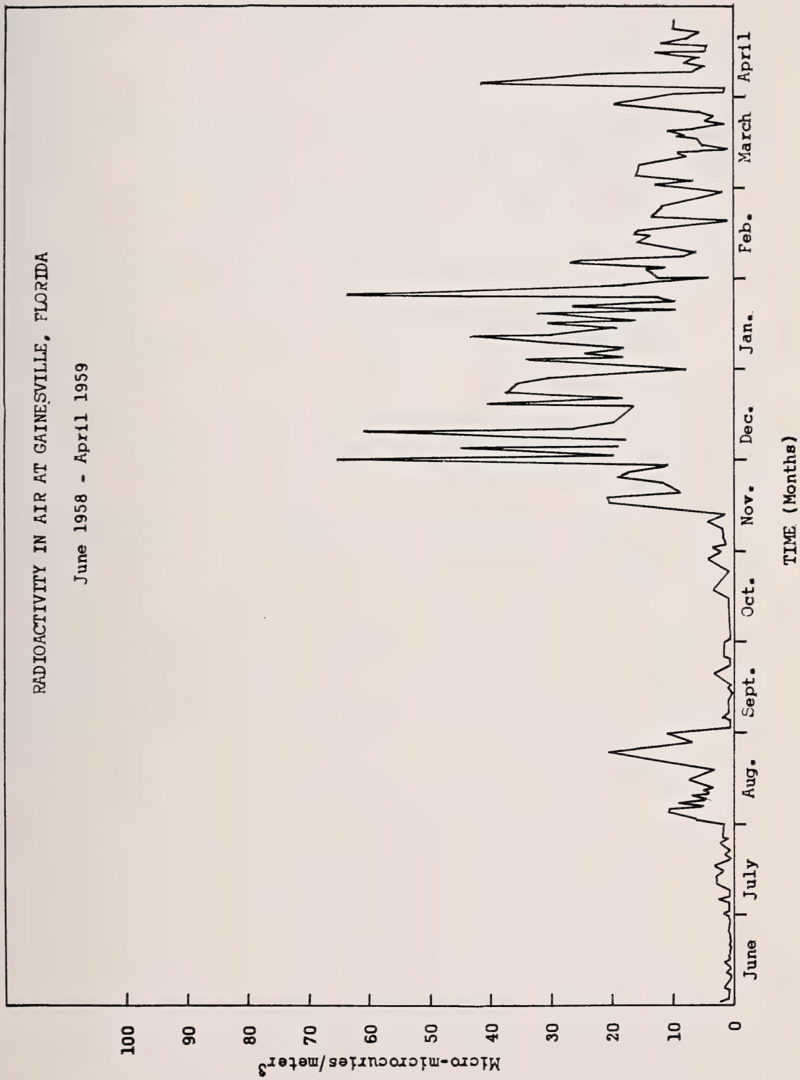
Figure II presents data from "rain-out". The period August to November, 1958 was affected by weapons tests. After the testing ceased the radioactivity dropped to a low level where it still remains.

Radioactivity in ground water (Figure III) is not affected by low level "fall-out" to the extent of air and rain because the soil and vegetation remove most of the "fall-out". Heavy rains do tend to cause an increase in ground activity by leaching the "fall-out" from the soil. Porous sandy soil such as found in Florida is especially subject to this leaching. July, 1958 and April, 1959 show the effects of heavy rains on ground water activity.

Summary and Conclusions

The hazards concerned with increasing uses of radioactivity and radioactive compounds make it essential that preparations be made now for the necessary measurements of radioactivity in the environment. While the environment of Florida does reflect "rain-out" and "fall-out" of radioactive materials following nuclear detonations, their activity is below maximum permissible levels established by the National Committee for Radiation Protection. The underground water supplies contain only traces of the "fall-out" where surface waters and rain tend to be more active.

The increasing level of radioactivity in our environment makes the problem of radiation hazards more apparent. The problem must be assessed from the point of view that many phases of our



RADIOACTIVITY IN AIR AT GAINESVILLE, FLORIDA

June 1958 - April 1959

future life will utilize radioactivity and will contribute to the radiation exposure of the population.

For the purpose, a complete monitoring survey with sampling of air, water, sewage and related materials is necessary and should be strategically located relative to possible present and future sources of radioactive contamination. Such a survey conducted at the University of Florida is described in some detail including the facilities available and the technics used in the radiation measurements. A major function of such surveys is the accumulation of data relative to normal background concentrations of radioactivity. With such data available the significance of any radioactive pollution of the environment can be assessed. Much can be accomplished with minimum facilities and equipment but as the uses of radioisotopes increase more complex equipment, added personnel and greater scientific skill will be required.

The interpretation of the results of measurements of radioactivity is difficult and requires a broad knowledge and training in nuclear science.

One of the main difficulties in comparing monitoring results from different laboratories is the non-uniformity of standard calibration sources.

Bibliography

1. "The Role of the Public Health Laboratory in Radiological Science," by F. W. Gilcreas and G. B. Morgan. Presented at the 87th Annual Meeting of the American Public Health Association, Atlantic City, New Jersey, October 19-23, 1959.

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HERPETOFAUNAL SURVEY OF THE PINE HILLS AREA OF SOUTHERN ILLINOIS

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The Pine Hills area of southern Illinois has long been of interest to biologists because of the mixture of northern and southern flora and fauna occurring there. An examination of the relationships and ecology of this flora and fauna may provide a key to an understanding of the flora and fauna of the entire middle Mississippi Valley. Gunning and Lewis (1955) have reported on the fish, Layne (1958) on the mammals, and Mohlenbrock (1959) on the vegetation. The present paper summarizes our knowledge of the Pine Hills herpetofauna.

There are a number of references to the amphibians and reptiles of Pine Hills, but, with the exception of Smith (in press), none presents a complete list of the forms which are present. These other references include Garman (1892), Blanchard (1942), Minton and Minton (1948), Smith (1948, 1950), Stein (1954, 1955), Gunning and Lewis (1955), Layne (1957), Smith and Minton (1957), Thurow (1957), and Keiser (1958).

The Pine Hills area (referred to in this paper simply as Pine Hills) is located approximately two miles east of Aldridge in northwestern Union County, Illinois. It includes the three miles of north-south oriented bluffs called the Pine Hills, as well as the large swamp which lies at the foot of the bluffs in the Mississippi River floodplain (the swamp has been known both as La Rue Swamp and, more frequently, Pine Hills Swamp). The Big Muddy River is immediately to the north of Pine Hills; Wolf Lake Swamp is to the south. The area lies within the Alto Pass Quadrangle (U. S. Geological Survey topographic map, 15 minutes series) and forms a portion of the Salem Plateau Section of the Ozark Plateaus physiographic province.

Data on air temperature, precipitation, and other climatic features of Union County are summarized by Cagle (1942).

The eastern part of the area is characterized by dry limestone bluffs which rise 150 to 350 feet above the floodplain. These bluffs often have exposed vertical faces with talus slopes at their base. Oak-hickory forest covers the midslope and an oak forest the upland

(Rensing, MS). Small hill prairies are scattered along the western edge of the blufftops. Below and to the west of the bluffs lies a lowland red maple—honey locust—swamp cottonwood forest (Mohlenbrock, 1959). A swamp, fed by springs in the bluffs, occupies a large area west of this forest, and in places fingers of the swamp reach as far east as the gravel road which runs the length of the bluffs. The largest of the springs emerges from the base of a sheer cliff and its water flows immediately into the swamp; there is no clearly defined spring run. Each of the other springs is rather small, rises at the foot of a talus slope, and has a rocky run over which the water flows before reaching the swamp. Water temperature of the springs varies but little during the year from an average annual temperature of 13.3° C. Pumpkin ash, buttonbush, and water willow are the most abundant woody plants of the swamp. Duckweed and green algae cover the surface of the water in many places, and various grasses line the swamp margin. The swamp contains countless stumps and fallen trees. The area also contains three borrow pits which have a greater depth of water than the swamp but less aquatic vegetation.

For the loan of field notes I wish to acknowledge the generosity of Messrs. Donald Drapalik, Dean Graham, Dyke Howell, Ed Keiser, Jr., R. Earl Olson, C. Robert Shoop, and Dr. James N. Layne. Dr. William J. Riemer has read the manuscript and offered helpful criticism.

Unless otherwise noted, all the species listed are represented by preserved specimens in the collections of the Illinois Natural History Survey and the University of Illinois Museum of Natural History in Urbana, or in the personal collection of the author. Taxonomic discussions are based almost entirely on material in the latter collection.

AMPHIBIANS

Siren intermedia nettingi Goin. Gunning and Lewis (1955) have reported the Western Lesser Siren to be among the most abundant of the amphibians in the swamp, but it is rarely obtained by most collectors. Their use of an electrical shocker to stun aquatic forms ordinarily obtainable only by seining (Gunning and Lewis, 1957) may well account for their success. Lesser sirens ordinarily are collected in the vicinity of culverts in the early evening. They are active throughout the year.

Ambystoma maculatum Shaw. The Spotted Salamander occurs in two distinct microhabitats in Pine Hills—lowland woods and dry talus slopes, the latter a rather unusual habitat. Individuals probably wander up the dry face of the slopes in rainy weather or on cool evenings when they can avoid desiccation, but the reason for their seeking higher levels is not apparent. Salamanders taken from talus slopes have been either in or under rotten logs, but one specimen was collected in association with a ringneck snake under a flat stone at the base of the bluff. *A. maculatum* has been collected in February, March, April, August, September, and October.

Ambystoma opacum Gravenhorst. The Marbled Salamander is usually found beneath rotten logs and old boards in moist lowland woods. Minton and Minton (1948) collected one in loose soil beneath a large rock at the base of a cliff. None have been collected on the talus slopes. Individuals have been observed in April, May, August, September, October, and December.

Ambystoma talpoideum Holbrook. The Mole Salamander has been taken only once, in mid-October, in moist humus beneath a rock high on a dry talus slope. Apparently it shares the tolerance of *A. maculatum* for relatively dry habitats. The specimen, an adult male, is 20 mm. longer than any previously recorded example (117 mm. to the previous 97 mm.).

Ambystoma texanum Matthes. Adults of the Small-Mouthed Salamander are most easily collected during spring when they enter ponds for breeding. By the latter half of May the large-headed, darkly pigmented larvae have reached a total length of about 56 mm. At this time the upper gill ramus extends posteriorly to the sixth costal groove. By the second week in June a number of individuals have transformed. They have reached a total length of about 61 mm., the increase being almost entirely in tail length. The old larvae are noticeably lighter in color than the young larvae. The head has assumed the shape typical of adult *A. texanum,* and the upper gill ramus does not extend as far posteriorly as the foreleg. Most of the transformed specimens were collected under old boards near a pond. A number were found in association with *Plethodon g. glutinosus.* Small-mouthed salamanders have been observed in April, May, June, October, and December.

Ambystoma tigrinum tigrinum Green. Dr. Philip Smith informs me that there was an Eastern Tiger Salamander from Pine Hills in the Southern Illinois University Museum collection several years ago. An inquiry in April 1958 revealed no record of this specimen in the Museum card file; it may be that the specimen is lost. This salamander is frequently encountered in the hill country to the east and may be expected to occur in Pine Hills.

Diemictylus viridescens louisianensis Wolterstorff. The newts of Pine Hills are identifiable as *D. v. louisianensis* in spite of the fact that they attain a much greater length than is recorded for the race (122 mm. compared to 89 mm.). Despite the similarity in size to *D. v. viridescens,* adults lack any trace of red dorsolateral spots and have heavily black-spotted dorsa. The eft stage is not coral red but has a rusty brown dorsum which contrasts with the orange venter. The dorsum is spotted with black and the red spots in the dorsolateral row, when present, are less than half the size of those on typical *D. v. viridescens* efts of comparable length.

The aquatic stage is usually found only in the spring of the year and has been found in numbers both in wooded lowland pools and in the swamp. The eft stage is found most frequently in late summer and fall (one was taken in late April), and are usually discovered under rocks and logs, often a great distance from water. One eft was collected under a log on a high, dry talus slope in association with an adult *Rana pipiens.*

Desmognathus fuscus subspecies. Smith (1948) has reported *D. f. fuscus* from Pine Hills, but in a later work (in press) discounts the earlier record because no further specimens have been taken since that date. If this salamander is present, it undoubtedly represents a peripheral colony of the spotted dusky salamander, *D. f. conanti,* rather than *D. f. fuscus.* The only known Illinois population of *conanti* is in Pulaski County.

Plethodon dorsalis angusticlavius Grobman. The Red-Backed Salamanders of Pine Hills have been a source of taxonomic controversy in recent years. Thurow (1957) believes them to be *P. d. angusticlavius,* whereas Smith and Minton (1957) state that there is an isolated colony of *P. cinereus* (presumably the subspecies *cinereus*) in Pine Hills. Dr. Richard Highton examined a series of live specimens from the area and identified them as *P. dorsalis* (no subspecific identification was given). This series included the most *cinereus*-like individuals I could find. Grobman (1944) has stated that the ratio of stripe width to body width (expressed as a per cent) for *angusticlavius* is 28, for *P. c. cinereus* 45. The ratio for a series of 14 Pine Hills red-backs is 28.8 (24.5-32.3). The margins of the dorsal stripe are not sharply defined, but no zigzag pattern is evident on any specimen examined. Occasional specimens have a yellow, rather than red, dorsal stripe. There is little reason to doubt that the Pine Hills population belongs to the subspecies *angusticlavius,* regardless of the species designation.

During the warmer months the Red-Backed Salamander is found beneath rocks and logs on the sides of the bluff. During the colder months many become inactive, usually coiling tightly upon themselves like watch springs. However, near one of the small springs, they remain active, most specimens occurring in rock rubble and leaf debris along the spring run. Occasionally individuals are found completely submerged in the cold water. Winter submergence has been recorded for *P. c. cinereus* (Cooper, 1956), but not for *angusticlavius.* At this spring, gravid females have been observed in early February.

The red-backs are found near the spring only during the colder months, at which time there are virtually no adult *Eurycea* active (occasionally a larvae is found). During the warmer months, however, both species of *Eurycea* are abundant. This seasonal succession may tend to reduce competition. *Acris gryllus, Rana pipiens,* and *Rana clamitans* are frequently associated with the red-backs in and along the spring run.

Plethodon glutinosus glutinosus Green. The Slimy Salamander is infrequently encountered; my only records are for April, May, and September. Specimens are usually collected in moist, sheltered situations although several were observed wandering about on the forest floor on a warm, rainy evening.

Eurycea longicauda longicauda Green. Comparison of Long-Tailed Salamanders from Pine Hills with a series from northern New Jersey has revealed no significant differences. The animals are not *E. l. pernix* as indicated by Mittleman (1942), neither do they show any apparent influence from *E. l. melanopleura.* For that matter, a small series from Monroe County, Illinois, approximately 55 air miles northwest of Pine Hills, also shows no indication of *melanopleura* characters. The relationships of the two subspecies in Illinois could well afford re-examination.

Hovde (MS) demonstrates that larvae tend to exceed newly transformed individuals in size. The largest larva measured 80 mm.; the smallest transformed specimen 44 mm. Apparently the larval stage lasts at least two years, possibly longer. The presence of very tiny larvae from November through March indicates an extended breeding season of at least five months. Larvae are active in the springs and spring runs throughout the year, feeding chiefly on amphipods. Small larvae are virtually black while the large larvae are rather nondescript in appearance with an olivaceous dorsum mottled with dark pigment. The newly transformed salamander, with its black sides, dark chin, dorsolateral row of white spots, and olive-grey dorsum, looks nothing at all like an adult *E. longicauda.*

Adults are most frequently taken under rocks, rotten logs, or leaf debris along the spring runs. On warm evenings during or after a rain, *E. longicauda* has been found in association with *E. lucifuga* on the walls and in crevices in a twilight cave, on the bluff face adjacent to the cave (apparently restricted to moss-bearing rocks), and wandering about on the ground. Adults are active throughout the year.

Eurycea lucifuga Rafinesque. The Cave Salamander appears to be less abundant than *E. longicauda* along the spring runs, but it is the more abundant of the two species in the cave, especially at night. Like the Long-Tailed Salamander, *E. lucifuga* is active throughout the year.

The larvae of *E. lucifuga* have not been found in Pine Hills. Since the larvae of the two species of *Eurycea* are very similar, one might suspect some of Hovde's specimens were misidentified. However, of 27 larvae which he chemically induced to transform, all proved to be *E. longicauda.*

Bufo americanus subspecies. Conant (1958) has indicated that the American Toads of southern Illinois belong to the subspecies *charlesmithi.* This is not an entirely satisfactory arrangement because many southwestern Illinois specimens do not agree well with published descriptions of the Dwarf American Toad, but appear to be similar to *B. a. americanus.* Clarification of the status of the American Toads of this area is perhaps the most pressing taxonomic problem affecting Pine Hills herpetology.

Specimens have been collected only in April and October.

Bufo woodhousei fowleri Hinckley. Fowler's Toad is more abundant than *Bufo americanus.* The two species may possibly hybridize. Specimens have been encountered in the lowland woods and occasionally on the road in April, May, June, and July.

Acris gryllus blanchardi Harper. Cricket Frog choruses have been heard and newly transformed individuals observed in mid-July. *Acris* is probably the hardiest frog in Pine Hills, remaining active about the springs in midwinter when all areas of still water are frozen solid.

Hyla avivoca avivoca Viosca. Specimens of the Western Bird-Voiced Treefrog from Pine Hills are distinguishable from small *Hyla versicolor* only in having a pale green rather than yellowish-orange groin and a brown rather than grey dorsum. Individuals found during summer were calling from trees or bushes in the swamp. Fall-collected frogs are invariably found in lowland woods and exhibit terrestrial tendencies. This is apparently characteristic of all the *Hyla* of the area. *H. avivoca* has been observed from April through October.

Hyla cinerea Schneider. The Green Treefrog is the most frequently encountered *Hyla* in Pine Hills. Both amplexing adults and newly transformed individuals have been seen in mid-July. These treefrogs have been collected from April through October.

Hyla crucifer crucifer Wied. Choruses of Northern Spring Peepers have been heard when the air temperature was only 1.1° C. and ice was forming on the shallow roadside ditches. Spring peepers are much less abundant in the fall than the other hylids and have been observed only in March, April, and October.

Hyla versicolor versicolor Le Conte. In late spring Eastern Grey Treefrogs may be heard calling during the day from the tops of tall trees at the margin of the swamp; they do not descend until after dark. *Hyla versicolor* seems to prefer drier situations than does *H. cinerea.* The possibility of an ecological separation between *H. versicolor* and *H. avivoca* should be investigated. The Grey Treefrog shares the activity pattern of most of the other summer-breeding hylids in being active from April through October.

Pseudacris nigrita triseriata Wied. The Chorus Frogs of Pine Hills apparently represent a population of "pure" *triseriata* situated well within the zone of intergradation between that race and the southern subspecies *feriarum.* Tibia/body ratio (expressed as a per cent) for a small series of males from Pine Hills is 40.8 (39.7-41.6). This is in marked contrast to the 46.2 (41.2-52.6) value for 10 populations from the zone of intergradation immediately to the northeast, and agrees closely with the 41.1 (37.6-46.5) mean for two *triseriata* populations from northern Illinois (Rossman, 1959). It appears that *triseriata* has been able to invade southwestern Illinois from the north by way of the Mississippi River floodplain and has withstood the influence of *feriarum*-like frogs from the hill country to the east. This is all the more remarkable in that Smith and Smith (1952) have shown *P. n. feriarum* to be the bottomland form in the Ohio River Valley.

Chorus Frogs have a very limited distribution in Pine Hills having been collected in only one pond. *Pseudacris* has been observed only in March and April.

Rana catesbeiana Shaw. Young Bullfrogs are active most of the year in the vicinity of the springs but do not appear to be as hardy as *Acris* and the other two species of *Rana*.

Rana clamitans. The Green Frogs at Pine Hills appear to be intergrades between *R. c. clamitans* Latreille and *R. c. melanota* Rafinesque. Mecham (1954) states that individuals from Alexander County, Illinois, are unusual in having dusky to black mottling or vermiculations on the belly, pectoral region, and throat. He says also that specimens from the adjacent counties have unmarked bellies. The majority of Pine Hills specimens (especially juveniles and subadults) have a heavily pigmented belly, the markings in some cases forming a reticulum. Mecham also mentions that males with green jaws and yellow throats are absent from the Mississippi floodplain of Union County. Although infrequent, such specimens do occur in Pine Hills.

Green Frogs are abundant throughout the year in and adjacent to the springs. Young frogs and subadults usually take shelter beneath rocks and logs along the spring runs during the cold months of the year.

Rana pipiens sphenocephala Cope. The Southern Leopard Frog is one of the three anuran species which is active throughout the year. All age groups reach their greatest abundance in and around the springs. One adult was collected in association with a *Diemictylus* eft beneath a log on a dry talus slope.

REPTILES

Chelydra serpentina Linnaeus. The Common Snapping Turtle is rarely seen except on the road or in the lowland woods when the female comes on land to lay her eggs. I have seen snappers in April and May.

Sternothaerus odoratus Latreille. The Stinkpot is the most frequently encountered turtle of the area. It has been observed in January, March, May, June, July, and August.

Terrapene carolina carolina Linnaeus. The Eastern Box Turtle is far less abundant in Pine Hills than it is in the hill country to the east. Specimens have been found on the road and in lowland woods in May and June. No influence from *T. c. triunguis,* which is common on the Missouri side of the river, has been noted.

Chrysemys picta. The few specimens collected appear to be intergrades between the western (*C. p. belli* Gray) and midland (*C. p. marginata* Agassiz) painted turtles and show no influence from the southern subspecies *C. p. dorsalis.* Several specimens have been taken on the road, and on June 12, 1955, a large female (carapace length approximately 160 mm.) was discovered laying eggs in a weedy field about 30 yards from the nearest water. Specimens have also been collected in April and May.

Pseudemys scripta elegans Wied. The Red-Eared Turtle is most frequently seen on the road when females emerge from the swamp to lay eggs. R. Earl Olson observed several females laying eggs on June 6, 1953. I have also seen this species in May.

Trionyx spinifer subspecies. On June 13, 1956, Ed Keiser collected the first specimen of the Spiny Softshell known from Pine Hills. I have not examined it and cannot say with certainty if the animal is a typical *T. s. hartwegi* or a *hartwegi* X *spinifer* intergrade.

Sceloporus undulatus hyacinthinus Green. The Northern Fence Lizard is the most abundant lizard and is most frequently found on or near the bluff. Fence lizards have been found from February through October.

Lygosoma laterale Say. The Ground Skink has been found in May and June in lowland woods, along the base of the talus slopes, and on top of the bluff. Foraging specimens are usually detected by the rustling noise that marks their passage through dead leaves and grass.

Eumeces fasciatus Linnaeus. Most specimens observed were on rocks or trees in the immediate vicinity of the bluff. Non-bluff-dwelling *Eumeces* were usually found around old abandoned wooden buildings. Specimens have been collected from April through October.

Eumeces laticeps Schneider. Stein (1954) reports the Broad-Headed Skink from Pine Hills. I have seen no specimens.

Natrix cyclopion cyclopion Duméril, Bibron, and Duméril. Keiser (1958) reports the rediscovery of this species in Illinois after an apparent absence of 50 years, and records its presence in Pine Hills for the first time. Specimens have been found on the road and in open and sheltered situations on the margin of the swamp. Four specimens measure from 358 to 991 mm. in length. Individuals have been collected in March, September, and October.

Natrix erythrogaster. The Plain-Bellied Water Snakes of this area appear to be intergrades between *N. e. flavigaster* Conant and *N. e. neglecta* Conant, and are the most abundant of the four species of *Natrix. N. erythrogaster* is both diurnal and nocturnal and during the day may wander some distance from water. Most individuals, however, are found near the swamp. Two specimens have been taken from the previously mentioned twilight cave, which may serve as a denning site for this species. On several occasions the snake guinea worm *Dracunculus ophidensis* has been observed to emerge from open sores on the backs of yellow-bellies.

The local *erythrogaster* exhibit a wide range of variation in coloration ranging from grey to dark brown dorsa, and pale orange-yellow to red venters. I have collected yellow-bellies ranging from 300 to 1095 mm. in length. These snakes are active from February through October.

Natrix rhombifera rhombifera Hallowell. The Diamond-Backed Water Snake is the largest *Natrix* in Pine Hills, attaining a length of 1295 mm. It has been collected from February through September both at night and during the day, but always in the immediate vicinity of water.

Natrix sipedon pleuralis Cope. Despite the abundance of this species elsewhere in southern Illinois, the Midland Water Snake is the least abundant *Natrix* in Pine Hills. It has been observed only in April and May, and is both diurnal and nocturnal.

Storeria dekayi wrightorum Trapido. The Midland Brown Snake has been taken both in open and sheltered situations during the months of April, May, July, and October, frequently near water.

Storeria occipitomaculata occipitomaculata Storer. The Northern Red-Bellied Snake is rare in Pine Hills; it has been collected only in March and April. C. Robert Shoop reports that an erythristic phase appears in Pine Hills in addition to the normally pigmented one.

Thamnophis sauritus proximus Say. The Western Ribbon Snake is infrequently seen in Pine Hills; my only records are for March, April, and October. All specimens have been collected in open situations near the base of the bluffs. The ribbon snake in this area is brightly marked with an orange dorsal stripe and greenish-white lateral stripes contrasting with a black dorsum.

Thamnophis sirtalis sirtalis Linnaeus. Eastern Garter Snakes have been collected during May, June, August, and October. All the individuals were juveniles or subadults. One specimen was found beneath a log in wetwoods; other individuals have been in open situations.

Virginia valeriae elegans Kennicott. The Western Earth Snake is relatively abundant in Pine Hills; specimens usually are found under rocks or debris. Occasional nocturnal activity has been observed in this species. Earth snakes have been collected every month of the year except February, March, July, and November.

Heterodon platyrhinos Latreille. The Eastern Hognose Snake is rare in Pine Hills. An erythristic adult collected in September beneath a log in lowland woods is the only specimen I have seen.

Diadophis punctatus. Gloyd, in Blanchard (1942), examined three Ringneck Snakes from Pine Hills and concluded that they were "fairly typical of *arnyi* in structural characteristics but in the spotting of the belly show tendencies toward *stictogenys*." Critical examination of 12 recently collected ringnecks (7 males and 5 females) reveals that the Pine Hills population consists of intergrades between *D. p. edwardsi* Merrem and *D. p. stictogenys* Cope. No individual is similar to *D. p. arnyi* in scutellation or belly pattern; none has red caudals or the accompanying caudal display behavior characteristic of *arnyi*. All have 15 dorsal scale rows, a trait shared by *D. p. edwardsi* and *D. p. stictogenys*. Eight of the snakes have seven supralabials, three have eight, and one has eight on the left side and seven on the right. In this character they are closer to the subspecies *stictogenys* which usually has seven supralabials. In regard to width of the light neck band, half the bands fall within the shared range of variation for both subspecies, two neck bands are too narrow for *D. p. edwardsi,* and four are too broad for *D. p. stictogenys.*

Table I compares ventral and caudal counts of Pine Hills ringnecks with data presented by Blanchard (1942).

TABLE 1

COMPARISON OF VENTRAL SCUTELLATION OF PINE HILLS *DIADOPHIS* WITH THE SUBSPECIES *EDWARDSI* AND *STICTOGENYS*

		edwardsi[1]		Pine Hills		*stictogenys*[1]	
Sex		M	F	M	F	M	F
Ventrals	Mean	151	160	149	160	133	142
	Range	(139-162)	(146-176)	(145-153)	(157-164)	(126-143)	(137-150)
Caudals	Mean	57	51	49	43	46	39
	Range	(48-65)	(41-61)	(46-54)	(41-46)	(38-51)	(33-43)

[1] From Blanchard (1942).

On the basis of ventrals alone, the Pine Hills snakes would be assigned to *edwardsi.* In caudal count, however, they are clearly intermediate, although somewhat closer to *stictogenys.* The ventral pattern shows a strong affinity to *stictogenys:* five individuals have ventral spots clustered near the midline and frequently fusing to form a transverse bar, three have a similar arrangement but lack bars, two have essentially a single median row of fairly large spots, at least anteriorly, and one has a virtually unspotted venter. Spotting of the infralabials and chin shields varies similarly.

From the descriptions Blanchard gives of two specimens from Alto Pass in Union County (one he called an *edwardsi,* the other an aberrant *arnyi*), it would seem reasonable to consider them *D. p. edwardsi* X *stictogenys* intergrades also. I doubt that any *arnyi* influence is expressed as far south in Illinois as Union County.

The ringneck snake is the most abundant of the small secretive snakes. Although this species is active from March through October, ringnecks are most numerous in the fall; the majority of fall-collected snakes are small and presumably young of the year. A ringneck taken in March was found with an *Ambystoma maculatum.*

Carphophis amoenus helenae Kennicott. Stein (1954) has reported *C. a. amoenus* from Pine Hills, but this record is probably in error since the nominate subspecies has not been recorded nearer than eastern Tennessee by other authors. The Midwest Worm Snake is less abundant than *Diadophis* and *Virginia,* but has been collected much more frequently than the Red-Bellied snake. Specimens have been taken near the bluff under rocks and beneath tar paper from April through September.

Farancia abacura reinwardti Schlegel. The Western Mud Snake has been collected from March through October, but its relative abundance is difficult to assess because of its aquatic habits. Two of eight specimens were collected at night. A 940 mm. mud snake was regurgitated by a 1067 mm. cottonmouth.

Coluber constrictor. Superficial examination seems to indicate that Pine Hills racers are intergrades between the Blue (*C. c. foxi* Baird and Girard) and Southern Black (*C. c. priapus* Dunn and Wood) Racers. The snakes are black dorsally but have a distinct bluish cast to the venter. My largest specimen measures 1397 mm.

The racer is an extremely active snake from March through October and has been taken throughout the area in practically every habitat except the swamp proper. It is found rather frequently on talus slopes. Pursued specimens often climb into bushes and shrubs. A large female, collected May 5, 1957, deposited a clutch of 19 nonadherent, granular-surfaced eggs on June 7. These averaged 32.4 mm. (30.1-36.5) in length and 19.5 mm. (18.4-20.2) in width.

Opheodrys aestivus aestivus Linnaeus. The Eastern Rough Green Snake is not abundant in Pine Hills. Several specimens have been found in the swamp on lotus leaves or in clumps of marsh grass. It has been observed from May through October.

Elaphe obsoleta obsoleta Say. The Black Rat Snake in Pine Hills does not show an approach to the southern subspecies *spiloides* as do many specimens from adjacent parts of southern Illinois. Some specimens possess orange venters, a condition not previously recorded for this subspecies. It is a relatively abundant snake and is found most often on the road or near the bluffs, occasionally in trees. Layne (1957) discovered a dormant Black Rat Snake in a crevice in a bluff in December. The longest *E. o. obsoleta* from the area measures 1930 mm. Specimens have been observed in April, June, August, September, October, and December.

Lampropeltis getulus. Smith (in press) includes Pine Hills in the zone of intergradation of the Black (*L. g. niger* Yarrow) and Speckled (*L. g. holbrooki* Stejneger) King Snakes. The small series available for my examination appears to be much closer to *L. g. niger* in pattern. The king snake is not frequently encountered, specimens having been collected in April and May in both open and sheltered situations. The largest specimen measures 1207 mm.

Lampropeltis doliata syspila Cope. The Red Milk Snake is the more abundant of the two species of *Lampropeltis* in Pine Hills, a situation which is markedly reversed in the adjacent parts of southern Illinois. Minton and Minton (1948) report finding lizard eggs in the stomachs of two Red Milk Snakes. I have found *syspila* under rocks on the talus slopes from April through July.

Cemphora coccinea Blumenbach. Bennett (1953) reports that Dr. Fred Cagle collected a Scarlet Snake in Wolf Lake Swamp in 1942. Since Wolf Lake Swamp is continuous with Pine Hills Swamp to the north, it is probable that the species also occurs in Pine Hills. No specimens have been collected since that date and the present-day occurrence of the Scarlet Snake in the area awaits substantiation.

Tantilla gracilis hallowelli Cope. The Northern Flat-Headed Snake was first reported from Pine Hills by Smith (1950). Dr. Smith advises me that most of his specimens of this secretive form were collected from the dry talus slopes along the bluffs, but some were found on the road.

Agkistrodon contortrix. Gloyd and Conant (1943) show Pine Hills lying within the zone of intergradation of the Southern (*A. c. contortrix* Linnaeus) and Northern (*A. c. mokeson* Daudin) Copperheads. Copperheads from Pine Hills appear identical to *A. c. contortrix* in color and are also closer to that race in width of dorsal band. It is the least abundant venomous snake in the area. Specimens have been collected both on the road and on the bluffs in April, May, July, September, and October.

Agkistrodon piscivorous leucostoma Troost. The Western Cottonmouth is undoubtedly the most abundant snake in Pine Hills.

A reliable observer reports seeing 50 individuals on the road in one day. In both spring and fall cottonmouths crawl across the road throughout its length as they move from talus slopes to swamp or vice versa. Dyke Howell reports finding a den of cottonmouths in a bluff crevice on March 25, 1959. The narrow crevice extended about 20 feet into the bluff and contained 15 to 20 snakes. The cottonmouth is apparently less affected by cold weather than most of the other snakes; it may be found on almost any warm day in midwinter. A freshly collected cottonmouth regurgitated an adult *Farancia*. The largest *A. p. leucostoma* measures 1194 mm. in length.

Crotalus horridus atricaudatus Latreille. Graham (1958) reports that 29 rattlesnakes from Jackson and Union Counties (including a few specimens from Pine Hills) agree with *C. h. atricaudatus* in all characters except number of dorsal scale rows. Approximately 70 per cent have 25 rows, 15 per cent 24 rows, and 15 per cent 23 rows. Graham interprets the occurrence of less than 25 rows (the usual number for *atricaudatus*) to indicate intergradation with *C. h. horridus*. In view of the agreement with *C. h. atricaudatus* in all other characters and the predominance of 25 dorsal scale rows, I consider them to be *atricaudatus*. The possible influence of *C. h. horridus* is not denied, but if it exists it is apparently of little consequence.

The Canebrake Rattlesnake is not abundant in Pine Hills and all but two specimens were collected on the road. One exception was collected in lowland woods; the other was sunning on rocks at a hibernating site on the talus slope. The rattlesnake has been observed from May through October.

Discussion

A number of amphibians and reptiles not presently known to occur in Pine Hills may be collected in the future. These animals fall into three categories: forms which occur along the bluff to the north and south of Pine Hills—*Rana palustris* and *Cnemidophorus sexlineatus;* aquatic forms occurring in the Big Muddy River which could enter Pine Hills when the river is in flood stage—*Necturus m. maculosus, Macroclemys temmincki,* and *Graptemys pseudogeographica;* forms occurring in the hill country to the east which rarely occur in the Mississippi floodplain—*Rana sylvatica* and _Lampropeltis c. calligaster_. An additional form, _Scaphiopus h. holbrooki_, has been recorded from two localities within a few miles of Pine Hills (one in the floodplain, the other in the hill country).

In analyzing the geographic composition of the Pine Hills herpetofauna one is impressed by the large number of forms which reach a limit of their range at or within a few miles of Pine Hills. These extraneous elements make up fully 40 per cent of the total herpetofauna, a marked contrast to the 22 per cent reported for both the fish (Gunning and Lewis, 1955) and the vegetation (Mohlenbrock, 1959).

The 31 intraneous forms (ones which do not reach a range limit near Pine Hills) include, for the most part, species and subspecies which range widely through eastern and southern United States. Almost no western elements are included. The 21 extraneous units may be placed into three categories with reasonable convenience. The southern element includes those forms which in general are found from the lower Mississippi Valley west to eastern Texas and eastward south of the Fall Line. The northern element includes amphibians and reptiles occurring east of the Great Plains and north of the Missouri River and the Fall Line. Members of the western element are generally found only west of the Mississippi River. Components of the three extraneous groups are listed below. Those intergrading forms which markedly resemble one parent stock more than the other are included and marked with an asterisk.

Southern

Ambystoma talpoideum
Hyla a. avivoca
Hyla cinerea
Natrix c. cyclopion
Carphophis amoenus helenae
_Agkistrodon c. contortrix_*
Agkistrodon piscivorous leucostoma
Crotalus horridus atricaudatus

Northern

Pseudacris nigrita triseriata
Eurycea l. longicauda
Terrapene c. carolina
Elaphe o. obsoleta
_Lampropeltis getulus niger_*

Western

Plethodon dorsalis angusticlavius
Thamnophis sauritus proximus
Tantilla gracilis hallowelli

Intergrading forms which appear to be completely intermediate between parent stocks (or on which data is insufficient) belong to the following groups: _Chrysemys picta_—western and northern; _Rana clamitans, Natrix erythrogaster, Diadophis punctatus,_ and _Coluber constrictor_—northern and southern. Table II summarizes the geographical affinities of the herpetofauna by order. Each of the "mixed" intergrades contributes one half unit for each parent stock area.

It is evident that snakes make up the bulk of the extraneous elements. Fifty-five per cent of the snakes are extraneous whereas no more than a third of the other orders are. Apparently the snakes have been able to utilize the available corridors (*e.g.*, the Mississippi Valley) and overcome the more formidable barriers (*e.g.*, the Mississippi River) to a greater extent than have the other reptiles and amphibians.

TABLE II

GEOGRAPHICAL AFFINITIES OF THE PINE HILLS HERPETOFAUNA

	Intraneous	Extraneous			Total
		Southern	Northern	Western	
Salamanders	7	1	1	1	10
Frogs and toads	7	2½	1½	0	11
Turtles	3	0	1½	½	5
Lizards	4	0	0	0	4
Snakes	10	6½	3½	2	22
Total	31	10	7½	3½	52

Of the extraneous elements 48 per cent are southern in origin, 36 per cent are northern, and 16 per cent are western. This contrasts rather sharply with the previously mentioned reports on the fish and vegetation in which the southern elements constitute 100 per cent and 93 per cent of the extraneous forms respectively. The southern group apparently moved northward in the Mississippi embayment where it enjoyed an essentially coastal plain flora and fauna. Although most of that group extend up the Valley to the north of Pine Hills, almost none of them has penetrated very far east of the Pine Hills. The northern elements have either utilized the Valley to come south (*Pseudacris* and *Elaphe*) or have moved in from the hill country, but have been unable to surmount the barrier presented by the Mississippi River. Few western elements have been able to cross the river, and these, like the southern forms, have not penetrated far to the east of the Valley.

LITERATURE CITED

BENNETT, ESTHER

1953. An Illinois record of the scarlet snake. *Herpetologica,* vol. 9, pt. 4, p. 164.

BLANCHARD, FRANK N.

1942. The ring-neck snakes, genus *Diadophis. Bull. Chicago Acad. Sci.,* 7(1): 1-144.

CAGLE, FRED R.

1942. Herpetological fauna of Jackson and Union Counties, Illinois. *Amer. Midl. Nat.,* 28(1): 164-200.

CONANT, ROGER

1958. A Field Guide to Reptiles and Amphibians. Houghton Mifflin Company, Boston.

COOPER, JOHN E.

1956. Aquatic hibernation of the red-backed salamander. *Herpetologica,* vol. 12, pt. 3, pp. 165-166.

GARMAN, H.

1892. A synopsis of the reptiles and amphibians of Illinois. *Bull. Illinois State Lab. Nat. Hist.,* vol. 3, art. 13, pp. 215-389.

GRAHAM, DEAN

1958. The rattlesnake in Jackson and Union Counties, Illinois. *Bull. So. Illinois Herp. Soc.,* 1(1): 2-3.

GROBMAN, ARNOLD B.

1944. The distribution of the salamanders of the genus *Plethodon* in eastern United States. *Annals New York Acad. Sci.,* 45(7): 261-316.

GUNNING, GERALD E., and WILLIAM M. LEWIS

1955. The fish population of a spring-fed swamp in the Mississippi Bottoms of southern Illinois. *Ecology,* 36(4): 552-558.

1957. An electrical shocker for the collection of amphibians and reptiles in the aquatic environment. *Copeia,* 1957(1): 52.

HOVDE, KENNETH N.

MS. Observations on *Eurycea longicauda* larvae in southern Illinois.

KEISER, ED, JR.

1958. The green water snake in Illinois. *Herpetologica,* vol. 13, pt. 4, p. 260.

LAYNE, JAMES N.

1957. Notes on a dormant pilot black snake. Copeia, 1957(1): 49.

1958. Notes on mammals of southern Illinois. *Amer. Midl. Nat.,* 60(1): 219-254.

MECHAM, JOHN S.

1954. Geographic variation in the green frog, *Rana clamitans* Latreille. *Texas Jour. Sci.*, 6(1): 1-24.

MINTON, SHERMAN A., JR., and JOHN E. MINTON

1948. Notes on a herpetological collection from the middle Mississippi Valley. *Amer. Midl. Nat.*, 40(2): 378-390.

MITTLEMAN, M. B.

1942. A new long-tailed *Eurycea* from Indiana, and notes on the *longicauda* complex. *Proc. New England Zool. Club,* 21(20): 101-105.

MOHLENBROCK, ROBERT H.

1959. A floristic study of a southern Illinois swampy area. *Ohio Jour. Sci.,* 59(2): 89-100.

RENSING, MARVIN

MS. The vegetation of the Shawnee Hiking Trail. Unpublished Master's Thesis, Southern Illinois University, 1957.

ROSSMAN, DOUGLAS A.

1959. Chorus frog (*Pseudacris nigrita* ssp.) intergradation in southwestern Illinois. *Herpetologica,* vol. 15, pt. 1, pp. 38-40.

SMITH, PHILIP W.

1948. Noteworthy herpetological records from Illinois. *Nat. Hist. Misc.,* no. 33.

1950. Additional noteworthy herpetological records from Illinois. *Nat. Hist. Misc.,* no. 56.

In press. The amphibians and reptiles of Illinois.

SMITH, P. W., and S. A. MINTON, JR.

1957. A distributional summary of the herpetofauna of Indiana and Illinois. *Amer. Midl. Nat.,* 58(2): 341-351.

SMITH, P. W., and DOROTHY M. SMITH

1952. The relationships of the chorus frogs, *Pseudacris nigrita feriarum* and *Pseudacris n. triseriata. Amer. Midl. Nat.*, 48(1): 165-180.

STEIN, HILDA A.

1954. Additional records of amphibians and reptiles of southern Illinois. *Amer. Midl. Nat.,* 51(1): 311-312.

1955. The range of the cave salamander in Illinois. *Herpetologica,* vol. 11, pt. 2, p. 153.

THUROW, GORDON R.

1957. Relationships of the red-backed and zigzag plethodons in the West. *Herpetologica,* vol. 13, pt. 2, pp. 91-99.

MACROCALLISTA NIMBOSA AT ALLIGATOR HARBOR[1]

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Macrocallista nimbosa Solander is a large and colorful marine pelecypod of the family *Veneridae.* It is confined to the western North Atlantic where its range is from North Carolina to Florida and the Gulf of Mexico. There is only one other species of this genus known for the same area, *M. maculata* Linnaeus, having a similar but somewhat more extensive range (Dall 1902, Clench 1942).

M. nimbosa occurs in shallow water of stable salinity where it burrows in sandy bottom. Adult shells are mostly 4-5 inches long and, because of the colorful radiating pattern of the shell, are commonly called "sunray venus" (Abbott 1954, p. 416, plate 39, fig. b). This clam is edible and of excellent flavor, however, it has never been an item of commerce because, as Clench (1942) states, "Though not rare within its range, it does not appear to be excessively common at any locality".

Since the establishment of the Alligator Harbor Laboratory of the Oceanographic Institute, Florida State University (in 1950), the Alligator Harbor area has become relatively well-known with respect to the abundance and distribution of most of the common marine invertebrates (Menzel 1956). *Macrocallista nimbosa* has usually been taken in living condition whenever collecting by digging was done in suitable habitats, so that it was regarded as a common species but not an abundant one.

During the summer of 1959, however, collecting of marine invertebrates on the sand and sea grass flats off the end of Alligator Point in connection with a course in marine biology indicated an unusually dense population of *M. nimbosa.* Accordingly, a limited amount of quantitative sampling was done between July 15 and 22, 1959, and the results are reported herein.

Thirteen one-meter quadrats were sampled on the flats off Alligator Point, some chosen at random, some selected. A total of 84 live clams were taken from these quadrats by digging to a depth of 1.5 to 2 feet. The most productive quadrat yielded 16 clams, two yielded 15 each, and two yielded 9 each. An average of 6.46 clams were taken per quadrat.

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[1] Contribution No. 131, Oceanographic Institute, Florida State University.

While occasional live specimens were found on the surface, the vast majority were beneath, most of them at a depth of 6 to 8 inches, but it is estimated that at least one-third were 12 inches deep or more. A few were found as deep as two feet and it is thus possible that some were deeper and missed.

While a few clams were found beneath the stands of sea grasses (*Diplanthera wrightii* (Ascherson) Ascherson and *Thalassia testudinum* König), the average number under grass was less than one per square meter. The large populations were found in sandy depressions surrounded by sea grass but free of it. The sea side and the land side of the grass flats were not sampled.

A sample of 30 specimens was measured for length, height, and width. The results are summarized in the following table:

	length	height	width
smallest	73	40	21 mm
mean	94.5	49.5	26.5
largest	116	59	31
average	95.6	51.8	26.2

The dimensions given above, when compared with averages given in the references cited, suggest that this population was composed of medium-sized rather than mature individuals.

The abundance of this clam in the area sampled was more than adequate to support a commercial fishery, provided such population density were prevalent over a sufficiently extensive area. There are many square miles of habitat that would appear to be as suitable for *M. nimbosa* as the area sampled.

Continued annual sampling of this population is needed to determine whether it represents an unusual peak or whether it is more or less stable, and whether it extends into neighboring areas in such density.

Literature Cited

ABBOTT, R. T.

1954. American Seashells. i-xiv, 1-541, pl. 1-40, text-figs. 1-100. Van Nostrand, New York.

DALL, W. H.

1902. Synopsis of the family Veneridae and of the North American recent species. Proc. U.S. Nat. Mus. 26: 335-415.

CLENCH, W. J.

1942. The genera *Dosinia, Macrocallista* and *Amiantis* in the western Atlantic. Johnsonia, Vol. I, No. 3, pp. 1-8, pl. I.

MENZEL, R. W. (Editor)

1956. Annotated check-list of the fauna and flora of the St. George's Sound-Apalachee Bay region, Florida Gulf coast. Contr. No. 61, Oceanogr. Inst., Fla. State Univ. i-iv, 1-78, 1 map. Mimeo. Sep.

Quart. Journ. Fla. Acad. Sci. (1959), 22(4), 1960.

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